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ABSTRACT

Although not a quantitative survey of undergraduate teaching of the history of science, this report presents information obtained from teachers and students nationwide. The report indicates that the classes in the history of science at many schools are filled largely by students majoring in the technical studies of science, engineering and medicine. A chapter is devoted to curriculum experiments in different colleges to make the history of science a part of the trend towards broader humanistic and social awareness. Curriculum materials, such as texts suitable for undergraduate instruction and audio-visual aids, are considered. Tables included in the report show information related to degree subjects of faculty and graduate students now in History of Science, and degrees in the History of Science awarded 1968-1975 in Canada and the United States. (Author/EB)

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REPORT ON UNDERGRADUATE EDUCATION IN THE HISTORY OF SCIENCE

Submitted by the Committee on Undergraduate Education
of the History of Science Society

December 1975

COMMITTEE ON UNDERGRADUATE EDUCATION
OF THE HISTORY OF SCIENCE SOCIETY

Stephen G. Brush
University of Maryland, College Park

Harold L. Burstyn
William Paterson College of New Jersey

Sandra Herbert
University of Maryland, Baltimore County

Michael S. Mahoney
Princeton University

Nathan Sivin
Massachusetts Institute of Technology

Harold Issadore Sharlin, Chairman
Iowa State University

Preface

This Report is being submitted three years after the appointment of the Committee on Undergraduate Education. Although this is not a quantitative survey of undergraduate teaching of the history of science, the Committee has had wide exposure to the field through correspondence from and consultation with teachers and students around the country, in response to announcements in the History of Science *Newsletter* and the American Historical Association *Newsletter*, and to data from the previous surveys of others.

The Committee held sessions at two annual meetings of the History of Science Society and sponsored a meeting with a group of consultants from outside the history of science. On 19-20 May 1975, a conference on undergraduate education drew to Iowa State University about forty people who teach undergraduates and who prepare graduate students for teaching undergraduates. The theme was graduate education vis à vis undergraduate teaching.

Two grants from the Alfred P. Sloan Foundation made possible the meeting with consultants, the Conference, and the meetings of the Committee. These grants also made possible the editing, printing, and distributing of the Interim Report and this Report. The Committee is grateful for the Sloan Foundation's support, which made our work immeasurably easier.

Through all the information that has been gathered, the conversations with numerous historians and historians of science, and the discussions among ourselves, the Committee feels that we have obtained a sense of the place of undergraduate teaching in the history of science and what some of the more promising directions for development are.

The profession has long been developing a close association with science, engineering, and medical departments. Undergraduate classes in the history of science at the many schools we are familiar with are filled largely by students majoring in these technical studies. That relationship is a sound one, and it demonstrates one of the more important functions of the history of science: to provide a historical background for the scientifically based professions.

These links with science, engineering, and medicine are being strengthened, and the Report devotes a chapter to imaginative experiments in different colleges to make the history of science a part of the trend towards broader humanistic and social awareness. As a discipline, that is, in the research and publication of members of the profession, the history of science has been, in large part, directed towards answering questions about the historical role of the scientist in society. The articles and books in print are not as useful as they might be in teaching students in the social sciences and humanities. As pointed out in the Report, one of the anomalies of the history of science is its isolation in history departments. Although historians indicate a desire to incorporate the history of science in their

courses, few feel they are adequately provided with support through publication and intellectual association. One fruitful direction for further development of undergraduate teaching in the history of science lies in developing closer links with other historians. A number of imaginative efforts to forge these links are described in the Report, but these are only the beginnings.

The history of science is one of *The Varieties of History* (New York, 1973), and as Fritz Stern wrote: there is a "recurrent need to redefine history in a broader context, responsive to the intellectual currents and political [one could substitute "practical"] concerns of a particular age." (p. 9) The history of science is essential to the understanding of the concerns of our age, and we have only begun to discover the ways of making it a part of the reform of undergraduate liberal studies.

The Committee's work has always been fascinating in spite of the inevitable discouragements in carrying out such a complex task. We have been apart spatially, often one or more of our members have been abroad, and we have been separated ideologically, but through some great good fortune our differences have resulted in a Report that, we believe, outlines the strengths of the history of science and points to achievements and opportunities that have been too long overlooked.

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Chapter I

The History of Science Profession

. . .we are convinced that the profession has hardly begun to fill the need in American education for historical perspective on science and technology.

THE HISTORY OF SCIENCE is a small profession whose accomplishments and difficulties make it a microcosm of American higher education. At a time when changes in our society and its economy make self-examination necessary, this Committee sought to find opportunities that were largely overlooked by historians of science when teaching their subject to undergraduates. Perhaps the most significant finding of our research was that almost everything anyone suggested might be done was already being done somewhere by one or more historians of science. What was at first a hypothetical consideration of principles became an inquiry into the patterns underlying the great variety of activities that had never been considered integrally. We believe that redefining the teaching role of our profession out of the multiplicity of its experience will be of interest and use.

The history of science, although distinct from the history of technology, regularly embraces the relations of science and technology and the role of science in society. Every society has sought to understand the nature of the physical world and man's relation to it. The outcome has been the varieties of science. The large-scale coordination of science and technology (the imperfect but immensely powerful marriage of knowledge and control) has led in less than two centuries to a way of life in which adaptation to change, rather than adjustment to stable institutions, has become the norm.

In technological[1] society, then, science is more than a source of intellectual insights into nature and of material benefits derived from those insights. It has evolved over a mere century from the calling of gentlemen adventurers at the frontiers of knowledge to a profession employing a sensible portion of the work force and increasingly dependent upon government for financial support. Science and technology induced a set of attitudes and habits of thought about reality and about knowledge. The indispensability of science, and its success at identifying its own goals with those of society has caused the methodological criteria of physical science to be held up as measures for other enterprises.

To the extent that undergraduate education seeks to enhance students' understanding of the society in which they live, the nature and impact of science and technology form an integral part of that education. But courses in the sciences and in engineering are ordinarily concerned with the activities and methods

[1]We will often use the word "technology" in the broad sense, including basic and applied science and engineering, except where the context (e.g. "science and technology") indicates a more restricted usage.

proper to those enterprises rather than with their manifold relations to society and to the individual. The social sciences and humanities are interested in relations between society and the individual as well as in changing cultural patterns. Yet courses in the humanities and social sciences do not adequately consider the role that science and technology have played in the development of modern society. All disciplines recognize the dominant place of science and technology in today's society, but the history of the growing importance of science and technology finds too little space in undergraduate courses.

How have the values and conceptions of a civilization or an era shaped its science? How have changes in scientific understanding and in technology affected the way societies and individuals see themselves? How do scientific professions shape the convictions of their members about what work it is proper to undertake?

Historians of science are best able to deal with these issues because of both their historical and scientific-technical training. In their courses they can show that science is a mode of human interaction governed by individual and social values and conceptions of reality. This notion of science contrasts with the one that sees it as the product of a succession of geniuses uninfluenced by their surroundings as well as the notion that makes it an automatic process generated by mechanical adherence to a "scientific method." They can explain the effects of science on society. Some of these effects are the world-views, which are derived from the metaphysical components of theories, that color the attitudes not only of philosophers but also of every thinking person.

Historians of science can help students to understand the role of aesthetic judgment in science and engineering. Understanding what technical people mean by beauty demonstrates an important link of technology to other kinds of human activity. Students should be critical of the myth of autonomous technology, the idea that technological change has a dynamism of its own, and of the myth of scientific determinism, the idea that science comes to have an increasingly dominant influence on human life by processes so objective and automatic that they need not be explained in terms of decisions, values, and socioeconomic interests.

The first history of science doctorate in the United States was awarded in 1942, and, as in any case of exponential growth, the number did not become statistically important for some time afterward (see Appendix I, Table I). Figures available from 1968 on for higher degrees in the history of science in the United States and Canada, given in Appendix I, Table II, may be compared with the membership of the History of Science Society (1100 in 1971 for the world, and 1300 in 1974).[2]

The Society is open to anyone who wishes to join. Tables III and IV in Appendix I show that within the Society similar categories of affiliation apply very differently depending upon whether they are defined by individual specification of professional interest or by membership in academic departments of various kinds. The figures in the two tables were compiled about a year apart, a fact that cannot account for more than a small part of the differences between them. The recent growth of the history of science as an academic profession is clearly shown by the

[2]The value of this comparison is limited because the membership of the History of Science Society is worldwide. Figures for U. S. and Canadian members would not really be more informative, since they are based on residence. For a great many members the degree and place of award is not noted in the *Directory*. Whenever possible, we provide figures below for the United States only. Although there are very close ties between United States and Canadian professions, not enough is known about institutional and individual patterns to assume that they are commensurable. For what the datum is worth, about 85 percent of the Society's membership lives in the United States or Canada.

relatively small proportion of the Society's membership who belong to history of science departments or who identify themselves as historians of science.

Even this apparently simple categorization of faculty members is likely to be confusing. Many graduate programs in the history of science are administered by history departments. Many departments that include "history of science" in their titles specify history of medicine, philosophy of science, sociology of science, or history of technology as well. Subjects listed in department names are shown in Appendix I, Table V; they include only United States programs. Multiple specifications are extremely common; the total of fifty listings in Table V correspond to only thirty-five programs that award the Ph.D. in history of science in the United States. Although "history of science" often accepts additional specifications in department titles, "history" does not. All thirteen (out of the thirty-five) are entitled simply "department of history."

We conclude from this profusion of grossly inadequate data that almost any generalization one might make about historians of science actually applies to few of the people who consider themselves entitled to be so called. We have attempted in this report to avoid confusion about which sense of "historian of science" we mean, and we use the term most often to refer to someone who teaches the history of science to undergraduates.

People professionally engaged in research or teaching in the history of science make up a diverse group. Those who teach undergraduates do so in a great variety of departments or programs. A minority — in 1974 only 16 percent of U. S. college and university faculty members who belonged to the History of Science Society — teach in history of science departments. Of the subset who state that their professional interest lies primarily in the history of science, 43 percent trained graduate students in 1972.[3] The percentage has diminished since then. Some history of science departments or programs provide undergraduate or postgraduate training in allied fields such as history of technology, history of medicine, philosophy of science, and sociology of science and some individuals teach in more than one of these specialties. A number of people who teach history of science belong to university or college history departments. Their contributions typically include civilization or general history courses in which relatively little consideration is ordinarily given to the role of science and technology in intellectual or social change. A larger number belong to science departments. They usually teach science courses as well as humanities courses meant primarily for science students. Some historians of science in all of these situations take part in lower-level general science or general education programs. Involvement in the humanistic side of premedical programs is also extremely common.

An increasing number of historians of science spend either all or part of their time in interdisciplinary and multidisciplinary programs. These compose a spectrum running from undergraduate majors heavily weighted toward history, such as medieval studies and American studies, to programs that focus on modern science and technology, whether of technology studies or science and society. Some members of the profession are involved in teaching, planning, and administering vocationally oriented programs in schools not organized along disciplinary lines. Some have experience in adult education, some in the training of high school teachers, and some in public television educational projects of various kinds.

Despite this diversity, which has been encouraged both by the increase of

[3] The first figure is from Table IV, and the second from the Carlberg Snow Report (Table III). On the nature of the information, see the Note appended to Table IV.

general concern about technology and by the contraction of traditional job markets for historians of science, we are convinced that the profession has hardly begun to fill the need in American education for historical perspective on science and technology.

A major trend in the recent reshaping of undergraduate education has been the attempt to evolve a twentieth-century version of liberal studies in which the humanities, social sciences, science, and technology are integrated. Although opposed by some humanists as an attack on the spirit of liberal education, this movement is seen by its proponents as an attempt to define a contemporary liberal education. Every voter must take personal responsibility at the ballot box for judging the opposed claims of technical experts testifying on the same issue and must be able to unwind the rhetoric of scientism as well as of antiscience. Scientists and others who work in science-based professions also need an informed public opinion to protect them from demagoguery. This threat comes both from those who manipulate attitudes toward technology and from irresponsible scientific spokesmen who call for a technological solution ("the technological fix") when the problem is primarily one of social or political priorities.

No single discipline can take the entire responsibility for addressing these concerns. Tools and insights widely dispersed through the traditional humanities and social sciences are called for. Each university and college must find a pedagogical solution that fits its circumstances and students.

At the same time, it is hardly surprising that historians of science are at the forefront of this effort to define a contemporary liberal education at one institution after another. No matter how narrowly construed, the history of science combines the tools and concepts of science, technology, the humanities, and the social sciences, necessarily crossing disciplinary and curricular boundaries. Among academic disciplines it provides one of the most natural springboards to cross-disciplinary studies. What is the most fruitful response of the profession to large-scale changes in American higher education?

On this issue there is no unanimity within the profession. Many historians of science think that reforming the humanities is not an appropriate initiative for a single profession; one's own time and one's students' time is best spent on what can be done most rigorously. We have no argument whatever with scholars who feel that the only bastion that can protect them from a destructive lowering of standards is a separate history of science department. Such judgments about the conditions for the success of one's work, based as they usually are on experience or observation, cannot be disregarded. But responsibilities of other kinds are increasingly being taken on by historians of science whose style bridges several disciplines. What intellectual risks are justified and what challenges engage one's sense of responsibility remain matters that each individual and, to a limited extent, each department must decide.

Certainly the History of Science Society should encourage reflection on and discussion (departmental and public) of the consequences of various self-definitions. It is important that members of the profession, as well as those who hope to enter it, are aware of the spectrum of options for engaging broad issues. How historians of science conceive their work and encourage their students to conceive theirs has a great deal to do with how large a part the profession plays in intellectual life and with how many vacancies there will be in the future. The relation of the number of potential openings for historians of science to the various ways in which the discipline is conceived can be investigated only with tools and

resources much more powerful than this committee has available. All we can do is point out that many more historians of science can survive in today's academic world if they are willing to invest the greater part of their professional identities, not in exclusive courses designed to train students as future historians of science. but rather in teaching courses conceived more broadly.

How can graduate training prepare teachers of undergraduates to meet the twin challenges of diversity and rapid change? How can the historian of science contribute to the education of students who know practically nothing about science, students who know history only as chronology rather than as a way of thinking critically about experience of change, or students whose early education was so defective that their most urgent need is to learn to think and write coherently? What help and encouragement should the profession extend to people trained in other fields who now teach the history of science? These are a few of the pedagogically centered problems that must be dealt with by a profession that until lately has concentrated most of its attention on graduate training and research. But teaching is more than a matter of a teacher's state of mind. What can the profession do to encourage teachers to share experiences and to help make generally available primary and secondary sources and other teaching materials suitable for undergraduate audiences? We have identified these questions as important for the future of the profession and determined that among its members are many who have worked hard and with some success toward finding answers to each of them. We believe that their reflections and ours may have some general utility within the academic world, and that this portrait of a profession's past, present, and potential responses to change may have some general interest.

Chapter 2

Background

As a discipline, the history of science has concerned itself with the significance of scientific research from the scientists' perspective; as a subject, the history of science seeks to understand the import of scientific methods and ideas to the public at large, represented by the undergraduate student body.

THE HISTORY OF SCIENCE began with Aristotle's attempt to evaluate the contributions of earlier natural philosophers as precursors of modern science – that is, of his own theories. With the growth of large organized scientific professions in the late nineteenth century, history was used to trace roots in the past and to depict these professions as obvious outcomes of millennial striving toward truth. As the catalogue description of the first American university survey course in the history of science put it (1905): "The aim of the course will be to make those who follow it acquainted with the sources of the broad stream of scientific knowledge as it exists today." Thus prospective scientists and engineers were taught that their professions were part of the ongoing flow of change in human culture, transformed as societies are transformed, but that the dominant criterion of interest was the present state of science.

Science as the subject of a career in historical studies caught the imaginations of a few people who made of it an academic discipline and then a profession. In 1915, two years after the founding of the journal *Isis* by George Sarton, an article assessing the history of science as a subject was published.[1] The author reported on the opinions of eminent people on the value of the history of science, gave statistics on the number of courses offered and noted a trend toward general history of science courses as opposed to history of individual sciences.

George Sarton was instrumental in organizing the History of Science Society in 1924 and bore great responsibility for the first American doctorate awarded in the history of science in 1942. He saw the history of science as "the leading thread in the history of civilization, the clue to synthesis of knowledge, the mediator between science and philosophy, and the veritable keystone to education." With great success, that first generation of specialists laid a foundation of rigorous research, defined standards of professional excellence, and built national and international organizations.

Between the prewar youth of the history of science and today's stock-taking,

[1]Frederick E. Brasch, "The teaching of the history of science. Its present status in our universities, colleges, and technical schools," *Science* 42:746-60 (1915).

there intervened a period in which professional identity was greatly sharpened and a presence established at most leading universities. This second generation was aware that earlier attempts to use the history of science to span the gap between the sciences and the humanities had been unsuccessful. In research and in training graduate students, they narrowed their concerns to what the methods already available allowed them to do with rigor. The development of scientific thought was traced and related to the general historical movement of ideas. Their most constructive contribution consisted, as a leader of the postwar generation put it, in "advancing our chosen subject, not in becoming the bridge between the subjects of others." What the postwar generation contributed was coherent and finite problems and techniques, in place of the more universal, synthesizing, and positivistic convictions of the founding generation. In doing so, they internalized to a greater degree than before the internalist-externalist dichotomy – the division between those interested primarily in scientific ideas and those interested in the connections of these ideas to other thought and activity. Ironically that dichotomy is now increasingly being rejected by intellectual leaders in the field. It is still useful, of course, as a tool of analysis, but it is confining as a norm.

The professionalization of the history of science did not result in ignorance of other disciplines. On the contrary, prospective teachers were usually given some postgraduate training in science and in history and were encouraged to pursue research in other disciplines as their topics demanded. But it was generally felt that the exigency of the time was to cooperatively construct an edifice of sound learning, and that this was best done if one's own writing was primarily directed toward one's colleagues. As the results of research accumulated, members of the profession became aware that no comprehensive intellectual history could ignore science and no mature consideration of social change could neglect the force of technology. But this has remained a conviction upon which few except historians of science and technology are prepared to act. The same professionalizing impulse that succeeded in giving the history of science a voice in the faculties of most major research-oriented institutions led those most dedicated to it to give relatively low priority to themes that could not be adequately studied within disciplinary bounds.

The establishment and expansion of the history of science was part of the growth and fundamental transformation of American education. Expansion of funding on a scale previously unthinkable brought the multi-university, the lightning metamorphosis of state teachers colleges into state colleges, and the enlargement of state universities. Science changed, its relations with technology changed, and the relations of both to society changed. Children reaching college age in the last five years have been much less inclined than their elders to comfort themselves by pretending that they still live in a stable, orderly and humane world. The majority of undergraduates probably accept the idea (with which they are constantly indoctrinated) that the technological fix is the solution to problems that involve technology. Nevertheless, they are seldom able to resolve the conflict between this assurance and their perception of a big science and technology tightly integrated into the unresponsive and failure-prone "system." This is not a radical viewpoint, since the great majority of young people simply make it part of the background of their lives. It certainly colors their response to science and technology.

The long postwar cycle of feverish expansion and unanticipated contraction provided the background for major changes in the history of science. The boom

suggested, however briefly, the prospect of unlimited growth. The directions of this growth were along the lines of the ideal that was prevalent when the boom began – methodologically rigorous research on well-defined questions. But the same experience that gave rise to ambivalent public attitudes towards science over the past ten years prompted a reassessment of research and teaching priorities by many historians of science.

When the history of science is considered as an undergraduate subject, all the contemporary intellectual and social forces press to make the subject answer immediate concerns. Like their colleagues in other specialized areas of history, historians of science have been thinking of their subject as a means of educating students about what the pursuit of scientific understanding has meant in times and places other than our own. As a discipline, the history of science has concerned itself with the significance of scientific research from the scientists' perspective; as a subject, the history of science seeks to understand the import of scientific methods and ideas to the public at large, represented by the undergraduate student body.

To sum up, the establishment of the history of science as an academic discipline at many universities in the late 1950's and early 1960's required a sharply defined professional identity. Professional recognition of the history of science is now no longer at issue. Unlike a quarter-century ago, historians of science now have both the professional self-confidence and the foundation of accomplished scholarship to begin developing the history of science as an undergraduate subject. Involvement across disciplinary lines is no longer so threatening to one's disciplinary standing as it once was.

The training of graduate students and undergraduate majors is still considered by many new Ph.D.'s to be the best of all possible careers. This attitude is a natural byproduct of professional socialization. Such careers have never been available to the majority of young teachers, and there is every reason to expect that they will become much less available in the future. Necessity has increasingly encouraged members of the profession to make useful contributions of a kind that, a decade ago, most graduate students would not have been aware of.

Chapter 3

Prospects

Historians of science are teaching undergraduates in a wider variety of institutions than they were a decade ago. The problem of finding some common focus to relate teaching and research, never a trivial problem, has become a stumbling block for many.

RECENT CHANGES in higher education affect the careers of historians of science and the future of the departments and programs in which they teach. These are (1) the economic difficulties, in absolute terms, of educational and research institutions; (2) a change in the center of gravity of higher education that has reduced the power of research-oriented, departmentally organized universities, though it has not much reduced their status; (3) changing attitudes toward education on the part of the general public; and (4) changing patterns of research funding that give much greater emphasis to contemporary issues and pay little attention to the claims for support of basic research.

Many suggest that these changes mean the doom of scholarship, while others suggest that, since they will quickly pass, the only thing to fear is pessimism. Though the Committee is not able to gauge the depth or duration of these changes, we discourage historians of science from ignoring them. It is quite true, as some members of the Society feel, that the situation could quickly become much better. Since those who have seriously studied recent trends have attempted to achieve balance and to point out uncertainties, it is clear that the picture could just as easily become much worse than current predictions make it. The ways in which experts in such things slice the pie of the present and extrapolate their graphs into the future are based on too many simplifying assumptions to make their figures worth quoting. But the trends they have described provide food for thought.

Whether one is an optimist or a pessimist, it cannot be denied that educational expectations have been lowered. This has made the traditional universities somewhat less appealing to students and their families for whom social mobility is not a strong motivation. The sense of an attenuating job market has encouraged a wholesale migration of college students into fields that appear to be relatively secure. For achievement-oriented students this has meant an abnormal concentration in premedical and prelaw majors. Since many history of science

programs have subsisted for years on large numbers of premedical students, this change is not necessarily disadvantageous. But the formation of new career patterns in the next several years by students who have been rejected by the medical schools may have completely unforeseen consequences for premedical programs. The movements of students out of physics into biology and out of the humanities into the social sciences also have implications for undergraduate interest in various kinds of history of science courses.

In this period of rapid transition, the budgetary constraints of the universities are making it more and more difficult for history of science departments to keep a reasonable number of untenured members. A greatly increased concern with enrollments and contact hours has put a premium on easy ways of attracting students. Although there is no reason to doubt in principle that historians of science are better prepared than others to teach the large courses in the occult and the history of pseudoscience that have sprung up at many universities, we note in some cases a lack of enthusiasm and self-confidence on the parts of those assigned to teach them.

We have already pointed out (Table IV) that more faculty members of the History of Science Society belong to science and medicine departments than to any other kind, that history and humanities departments are next most frequent, and that history of science and medicine come third. This order is anything but stable, and patterns of hiring new Ph.D.'s (and especially of tenure-line appointments) are bound to change it considerably. The expansion of history departments, which has made room for many historians of science in recent years, has slowed so greatly that the competitive odds against people considered marginal have become immensely greater. History of science is contracting in many institutions and expanding in very few. A considerable redistribution of resources and enrollments is thus underway between various fields of science. Even were this not the case, the membership of the History of Science Society reflects the greater tendency of science departments three and more decades ago to hire historians of science. This is demonstrated by the high proportion of emeritus members of science departments in the History of Science Society and the small number of emeritus professors of history departments. Interdisciplinary programs are the area of greatest growth, but this growth began so recently that faculty members who devote a major part of their effort to such programs made up an insignificant part of the Society's membership in 1974.

Complex changes in the pattern of research funding are the results of changing values as well as changing finances. The idea of basic research as the cornucopia from which all the fruits of technology spill out is no longer listened to by the public with the same attention as it was a generation ago, and indeed it is believed by far fewer scientists and engineers. The history of science is bound to be affected directly by a tendency well under way for agencies and foundations to specify areas or problems for funding rather than react to applications as they come in. Ethical and human value aspects of science and technology and current problems concerning science and society are areas already marked out by foundations for the support of history of science research. Whether research on early science will be penalized in the long run remains to be seen. It is significant that the History of Science Society is now conferring with funding agencies in order to see that the profession has a voice in the definition of new patterns. Seen as a whole, these recent developments make the individual historian of science much less an entrepreneur in a free market than used to be the case.

It might be argued that community and junior colleges, vocationally oriented universities, and similar institutions not primarily oriented toward professional education, have been a major component of American higher education for a long time. Though their voices have not until recently been compelling enough to be heard by most professional societies, we expect them to be heard with increasing attention in the future. They continue to grow at a time when other sectors of higher education are shrinking or fighting hard to hold steady. More state university students are transfers from junior colleges. More historians of science now teach in community and junior colleges and are able to tell others about their successes and problems. It is becoming more widely known that they are not mere bad copies of more prestigious institutions. In view of their emphasis on basic skills, for instance, there is no rationale for their organization according to the traditional disciplines and little justification for them to pursue the prestige that distinction in research yields elsewhere in academia.

The point to which these wearisome reflections have led us is simple: it is worth considering the possibility that a broad base of capability and activity offers more likelihood of individual or departmental survival than a narrow one.

Effects of These Changes Upon Undergraduate Education in the History of Science

A great many of the dislocations experienced by historians of science over the last five years have been felt throughout academia. Changes in individual career prospects parallel a narrowing of program prospects and of research opportunities. In departments that teach both graduate and undergraduate students, there has been pressure to give the latter greater priority. Most graduate programs in the history of science have shrunk slightly over the last five years, and more of the recent Ph.D.'s are in jobs that do not lead to consideration for tenure.[1]

Historians of science are teaching undergraduates in a wider variety of institutions than they were a decade ago. The problem of finding some common focus to relate teaching and research, never a trivial problem, has become a stumbling block for many. For those outside academic programs, the interests and motivations of students differ sufficiently from expectations either to rouse resentment or to pose a worthwhile challenge. Another common difficulty is learning to get along with colleagues who have neither the habits nor attitudes of research scholars. There is no automatic answer to the dilemma of the historian of science who has by great effort made a place for himself and his discipline in a history or humanities department, only to find that he or she is expected to serve as a utility historian rather than as a representative of his profession.

Relations With Other Disciplines

Historians of science agree that the history of science is interdisciplinary in character, but there has been very little discussion of what it means for a discipline

[1]These statements are based partly on discussion at the Conference on Undergraduate Education in the History of Science, Ames, Iowa, 19-20 May 1975, and partly on the documentation in Richard H. Schallenberg, "Second Annual History/Philosophy of Science Employment Survey" (unpublished, 15 December 1973).

to be interdisciplinary. The history of science is considered a discipline not because it has departments, journals, and professional societies, but because it has defined its own problems and developed methods to solve them. The methodology of the historian of science is fundamentally that of the historian, but the concern with scientific and technological change generates problems and concepts that are partly derived from the way scientists think about their work. This quality of sitting between disciplines (often reflected in the academic situations of historians of science) leads to frequent overlap with the work of other disciplines and subdisciplines that are similarly situated. This overlap may be ignored because of a sharply defined sense of what belongs to one's discipline and what does not.

It is our impression that most historians of science are interested in questions that cannot be answered satisfactorily within the confines of their own discipline, and that they generally have some acquaintance with and facility in another transitional field. The most important of these transitional fields are the philosophy of science; the sociology of science; the social and cultural anthropology of scientific communities; the use of psychology to study the discovery process; economic history; the history of the social sciences; and science policy studies. In some departments the overlap is institutionalized. Constant intellectual contact between faculty and students in a department of the history and philosophy of science or the history and sociology of science encourages added breadth in certain directions (and no doubt less breadth in others). On the other hand, not enough historians of science are aware that there are two doctoral programs in the history of psychology and a *Journal of the History of the Behavioral Sciences*, edited by a psychologist who belongs to the History of Science Society.

If the fields enumerated above are often considered distant relatives, the relation of the history of science to the history of technology is more like that of a sibling. As historians of science become more aware of the technological and social backgrounds of the developments they study, large issues in the history of technology become relevant. Discussion with members of the History of Science Society suggests that courses dealing with the history of science and technology taught by historians of science alone are now extremely common. On the other hand, historians of science and historians of technology do not necessarily approach technological developments in the same way. This is perhaps most clearly seen in the great five-volume *A History of Technology* (London, 1954). The outlook of the editors was more or less that of the history of scientific ideas. It might be argued that the book is a history of inventions rather than a history of technology, if the latter is considered to emphasize the use and consequences of techniques. It would be foolish to argue that one approach is better than another; our point is merely that historians of science whose interest is already developed may still benefit from closer association with historians of technology in developing and teaching courses.

Remarks of a similar kind might be made about the history of medicine. Historical studies of science and medicine diverged considerably during their emergence as academic disciplines; there is considerable overlap of interests, as well as of professional identification. *Isis* publishes articles on the history of medicine fairly frequently, physicians and historians of medicine make up a sensible fraction of the History of Science Society, and so on. But there has been little discussion of differences in methods and in disciplinary points of view.

Our purpose in reviewing these associated fields of study is in part to point out the multiplicity of connecting links already in place. The further development

of those links will no doubt be mainly a matter of individual interest and initiative. At the same time, it is possible to construct links on a much larger scale. The formation of the Society for the Social Study of Science (August 1975) is one example. We would like to voice the hope that the History of Science Society will construct a more exact picture of disciplinary linkages than it lies within our mandate to do. We also echo the frequently expressed wish that the Society explore ways to ease the entry of individual members into cross-disciplinary study and teaching. One means that deserves discussion is more sessions at the annual meeting in which people discuss the same problem from the vantage points of different fields.

Chapter 4

Historians of Science in History Departments

It is up to the historians of science to provide connections between ideas, values, and social realities that will help historians to address the concerns of our day.

A SUPERFICIAL PARADOX in the relations between history and the history of science bears examination. Most active historians are aware that the history of science is an important subject, but relatively few can specify its influence on their own work. The majority of newly graduated historians of science have recently been appointed within history departments, reversing the earlier trend toward appointments in science faculties. Many individuals report it is more difficult to establish intellectual relationships within such departments than with scientists and engineers. History courses that survey the main developments in American or Western thought and civilization ignore major scientific theories, which are reflected in changes of world view, and inventions, which have great influence on the organization of society. Historians of science in history departments are often encouraged to include more adequate coverage of these topics in their own sections, but rarely do other historians follow their example.

The success of Thomas S. Kuhn's *The Structure of Scientific Revolutions* (Chicago, 1962; 2d ed. 1970) has influenced the more theoretical or philosophically inclined historian. But whatever influence that book has had on historians lies in its usefulness for comparing the historical with the scientific enterprise. The historicization of science has enabled historians to compare history as an intellectual pursuit with science and, although the comparisons are often erroneous,[1] it has afforded a common meeting ground for historians of science and other historians.

Historians also learned about the nature of the history of science from Kuhn's article "History of Science," in the *International Encyclopedia of the Social Sciences* (New York, 1968), 14, pp. 74-83. In this essay a distinction is made between internal and external history of science in the course of describing the kind of work historians of science do. The integration of the two points of view is incomplete, and it may be that the distinction is an obstacle to bettering relations in history departments. Social historians have found useful the study of the institutional setting for scientific research. More books which follow the lead taken by Robert K. Merton's *Science, Technology and Society in Seventeenth-Century England* (New York, 1970, originally published 1938), but which press further and explore other social links, are needed for the alliance between historians of science and social historians to be broadened. Intellectual historians have long been interested in the history of

[1] See David S. Hollinger, "T.S. Kuhn's Theory of Science and Its Implications for History," *American Historical Review* (April 1973), 78, pp. 370-393.

science as a part of the history of ideas. The concerns of our own day, however, relate to the impact of new scientific theories and the resulting technology. It is up to the historians of science to provide connections between ideas, values, and social realities that will help historians of the various specialties to address the concerns of our day. An example to consider is that of the economic historians who understood during the depression years that their subdiscipline had something to contribute towards understanding the problems of that day.

The claims of the historian of science upon other historians are not unique. The latter have been beset by a variety of new research methods and tendencies, all of which clamor not only for attention but for personal adoption. Quantitative history, psychohistory, and oral history are examples of research methodologies that are sometimes represented – to their detriment – as disciplines. Although it is often argued by their most responsible champions as well as by their detractors that they are merely ways of generating meaningful historical data, there is no question that they have achieved the professional status of specialization. Scholars speak of themselves as quantitative historians or oral historians, and journals exist for monographic publication in these fields.

Unlike these "new" methodologies, the history of science is a subdiscipline of history similar to economic, social, or political history. Although the history of science is a relatively new specialization compared to other historical fields, the time is propitious for the history of science to be more fully integrated into undergraduate history courses. The times have raised questions about the social role of scientists, the economic costs and economic benefits of scientific research, and the importance of scientific knowledge in making political decisions affecting military and economic policy. The historical background to these questions form just that common ground on which historians of science can meet with other historians in their departments.

It seems to us that historians can be expected to respond to the value of the history of science for illuminating historical questions only to the extent that that value is proved. How can it, then, be proved? In this section we will review attempts made in a number of institutions to relate the history of science to history in undergraduate teaching.

Undergraduate Teaching in History Departments

The involvement of history departments in the history of science ranges from none at all to the situation at the University of California at Los Angeles, where up to fifteen undergraduate courses in the history of science, technology, and medicine are offered annually by the history department. In small colleges, where there is enthusiasm for the history of science, it is likely to be satisfied by a self-trained historian or scientist. This teaching responsibility often leads to enhanced depth of interest and a desire for specialized training which at the moment cannot be easily satisfied.

Historians of science in history departments, are usually responsible for teaching survey courses in American or Western civilization. In schools where there is sufficient demand, the major obligation may be teaching a survey of the history of science, which often includes considerable attention to the history of technology. Demand for such courses exists both in institutions with a strong technological component and in those that attract large numbers of premedical students. Courses

serving this latter clientele have incorporated a good deal of the history of medicine. Our investigation suggests, however, that recently there has been a tendency to shift the emphasis from the history of medical ideas to the history and contemporary problems of public health. This change reflects a reaction to an earlier overemphasis on the role of scientific medicine and the importance of new technical discoveries in the reduction of disease and mortality. Critical historians are now attempting to construct a picture in which, although technical innovation is not ignored, due attention is given to the responsibility of society for priorities that make possible the equitable delivery of health care. Other historians of science in history departments offer courses in the social history of technology, in science and society, or in science and culture when demand permits it.

Although it is seldom reflected in publication, there is a great deal of interest in religion among middle-class American students. The University of Oklahoma, for instance, finds that within their broad array of undergraduate courses in the history of science there is considerable demand for its lecture course on science and religion in historical perspective. At Geneva College, a small, church-related liberal arts college with an engineering program, religious aspects of the growth of science are a major theme in the history of science course.

Under conditions in which appeals to undergraduate demand are the rule, historians of science have shown considerable ingenuity in combining a large enrollment with intellectual substance. We have already mentioned the currency of courses on pseudo-science and the occult, which often attract more students than do surveys of the history of science, but advanced work in these fields is seldom offered. The committee is not prepared to assess the quality of courses in this area or even to estimate how greatly the quality varies. A number of them are taught by specialists in Renaissance and premodern science — fields in which the need for deep study of pseudo-science is recognized — and some historians publish regularly on the subject. Some historians of science are professionally concerned with public conceptions of science and make regular use of popular literature in their research. To give a single example, courses in "Science Fiction as Social Criticism" and "The Future as Utopia" along with seminars on "Buckminster Fuller" and "Photography and History" are among a number of offerings at the University of Delaware that teach students to explore the social implications of science and technology. The course on science fiction provides students with a critical framework for thinking about the technological aspects of current social issues.

The longer established courses in the history of science have expanded their enrollment by broadening their appeal. A potentially large enrollment exists in the liberal arts curriculum. To attract these students, some historians of science deal with our scientific-technological culture on the premise that "the history of a thing can tell you something about its nature."[2] How were past societies, in which science and technology were less dominant, different socially, politically, and economically? This historical contrast is a part of general education that historians of science are well equipped to provide.

Despite the attempts of historians of science to introduce technological themes into history survey courses, there seems to be no generally applicable formula for them to influence sections outside their own. The greatest success, of course, comes when they are in a position to play a considerable role in planning and staffing such courses. This expedient is not always available to large numbers of junior

[2]Hollinger, "T.S. Kuhn's Theory of Science," p. 389.

faculty. An alternative that may have wide applicability has been tried with success at the University of Kansas. "Satellite" courses, meeting one hour per week, are offered as a history of science supplement to students enrolled in a history lecture course. Another possibility, prevalent in engineering institutions, is to offer lower-level history or civilization surveys planned especially for science or engineering students.

The foregoing review of the activity of historians of science in history departments suggests a variety of ways in which they have made themselves useful, even indispensable. Some historians of science increase their influence by taking the initiative in organizing collaborative and team teaching in courses small and informal enough to allow substantial intellectual interaction. Such courses tend to be successful when two faculty members are allowed to bring equal strength to the classroom, and where the format requires continuous participation by both. An example of such a course is "Physics, History and Society" taught at Iowa State University by a historian of science and a physicist. The two instructors have developed a course of study that tries to illuminate the distinctive character of history and of science by placing the two subjects in opposition. A largely unexplored area is the collaboration of a historian of science and another specialist historian.

A great deal of the initiative in founding the history of science as an academic discipline was due to scientists, and it is still felt by a large number of graduate departments that considerable knowledge of some science is necessary in order to do productive work on its history. At the same time, the growth of the history of science as a discipline and as a profession has benefited greatly from the contribution of scholars who had nothing more than curiosity about science and its cultural and social implications. A great deal of work on early natural philosophy has been done by classicists with very little scientific knowledge. The major reconsideration of seventeenth-century science now under way is due in large part to the efforts of a number of English historians with very little training in the content of science. Individual examples could be multiplied indefinitely. In a 1972 survey of the History of Science Society (Table III), people who identified themselves as professional historians were fully a third as numerous as scientists and a quarter as numerous as professional historians of science. Some history of science graduate programs are hospitable toward students whose background is much stronger in history than in science.

Neither the contributions that have formed our contemporary understanding of the history of science, nor the practices of graduate programs considered together, nor the active composition of the History of Science Society justifies the view that every historian of science must have considerable knowledge of science. Such knowledge is, on the other hand, needed by people who teach many science students, especially in science departments (see chapter 5). There is only one rule that seems to be very generally accepted by historians of science, namely, that sound work requires a firm grasp of the methodology of the history of science itself, as well as mastery of the scientific and historical frames of understanding specifically required by the definition of the research problem. Limitations of scientific knowledge are thus not absolutely disabling; they merely limit the depth of rigorous investigation of the history of scientific theory and practice. Reasoning along those lines has made it possible for responsible individuals and programs to expect valuable contributions from a primarily historical orientation.

In order to strengthen the influence of the history of science on undergraduate

teaching, there is need for a great deal more attention in publications to historical analysis of the social aspects of science. We will mention a few topics that, while they are being taught, could use a better underpinning in the form of books and articles for a wide, unsophisticated audience:

1. The relations of science and religion. The continued interest of undergraduates suggests that a great deal more could be said on the historical and (at least by implication) contemporary relations of science and religion. There is very little in the way of historical studies relating the changing character of belief in religion to the changing beliefs of scientists on the one hand and laymen on the other about nature. This is a conventional topic in studies of the Enlightenment, but little attention has been paid to its role in later periods. There are many other largely unexplored topics of the same kind; for instance, the influence of growing and changing secular professions on ecclesiastical organization in times and places where the two competed for talent.

2. The ethics of technical professions. This is another topic upon which historians of science are engaged in cross-disciplinary study. A great deal of teaching and research, especially on contemporary topics, is going on. There is still a lack of general books, useful in undergraduate courses, on social responsiblity and ethics as recurring themes throughout the evolution of science.

3. The primary role of popularizers in shaping public conceptions of science. Historians of science have shown for a number of important cases, notably Newtonianism and Darwinism, how understanding of the philosophic consequences of new theories depended rather less on the discoverers than on those who used the discoveries to shape world views. There would be extremely widespread interest in a general book on popularization, the public relations of science, and other processes that mediate between scientific discovery and public image.

4. The mythology of modern science, medicine, and technology. There is a widely expressed need for a historical critique of scientific rhetoric. Historical, philosophic, sociological, and political analyses are needed for study of the changing relations between what science has been able to do and what its spokesmen, recognized and unrecognized, have claimed for it.

As part of what an anthropologist would call the social myth upon which the growth of science has been founded, the universality of scientific rigor has often been exaggerated and misrepresented. Formerly, it was widely felt that the training of scientists imparted a special authority to find disinterested and objective solutions to any human problem. Humanists who teach students strongly motivated toward science or engineering are aware of how difficult it is to convince certain young people that every problem does not have a single solution to be reached by objective methods – and that in life, as in art, ambiguity can be as invaluable as clarity. Although mature scientists do not seem on the whole to be less tolerant than other people, the language of scientism, which rejects "subjective" differences of outlook resulting from different sets of values, is often used in public discourse by people who would not dream of applying it in their private lives. It has also been employed heavily by engineers and physicians for analogous uses. A historical study of scientism would be invaluable.

Closer to the mundane work of the historian of science are the myths that technological innovation and the elaboration of scientific ideas are inevitable, that they unfold according to some autonomous inner logic rather than according to human volition. A disinclination to investigate the social and economic roots of

technological determinism was understandable at a time when economics and sociology themselves were too determinist to yield subtle answers. This is no longer the case, and more historians of science than before also have the philosophical tools to study the issues of value involved. Though considerable monographic work is underway, more writing for a general audience is to be desired.

These are a few of the issues on which historians are waiting to hear from historians of science. Their repercussions range from a better understanding of scientific professionalization to a clearer and more critical view of the advancing objectification of life and thought in modern America. These issues have engaged the imaginations of an increasing number of historians of science

Conclusion

Our survey of the work of historians of science teaching undergraduates in history departments suggests that they are pulling their weight in a diversity of ways, specialized and unspecialized. As for its influence on the discipline of history, the history of science is just emerging from a long period of internal disciplinary development; at the same time a shift to encompass political and social issues of special interest to all historians has begun only recently. Although work is under way on a broad range of topics of general interest and significance, most of the publication so far has been monographic and not easy for nonspecialists to use. There is a great need to encourage writing for historians and for nonspecialized readers in general, and we have suggested steps the History of Science Society can take to encourage such writing.

Chapter 5

Historians of Science in Science Departments

Programs designed especially for science and engineering students must cope with their preconceptions about history. These students are often eager to hear and argue about the most modern-sounding technical aspects of early science, which the historian's own training may have underemphasized and downgraded. They may or may not be willing to take seriously the kinds of questions that historians consider important.

A RECENT ARTICLE in *Science* (22 March 1974, 183, pp. 1164-1172) by S. G. Brush entitled "Should the History of Science be Rated X?" discusses the possibility that the history of science may be counterproductive in the professional socialization of scientists. Many teachers of science believe that students cannot devote themselves wholeheartedly to their future professions unless they accept such traditional myths as scientific determinism and autonomous technology. The author points out that deep and critical research of the kind that historians of science do is bound to threaten these myths and that those who train the young might do well to ask themselves whether that is what they want. By questioning the appropriateness of humanistic studies of science the author emphasizes their importance. His demonstration rests on the irony of people whose calling above all others esteems verifiable truth, considering the benefits of encouraging ignorance.

Many of those who now consider themselves professional historians of science (regardless of what field they were trained in) identify more closely with intellectual or social historians than they do with scientists. They are more interested in the relations of, say, seventeenth-century science to seventeenth-century philosophy, religion, and social institutions than in its relation to twentieth-century science. Others specialize in unravelling the origins and technical aspects of such long-rejected models as Ptolemaic astronomy, phlogiston chemistry, and Newton's notion of space and time, each of them valued as an attempt at understanding.

Despite the affinity with history, most historians of science who teach undergraduate courses in their field find that most of their students are not majors

in the history of science or any other branch of history (there are several prominent exceptions, such as Princeton). Many of the students come from science and engineering departments, impelled either by the desire for a broader view of their future professions or by the need to satisfy a history or humanities requirement.

A common characteristic of courses designed primarily for science and engineering students is the increased technical depth that is both possible and advisable. Students are most easily tempted to cross the bridge between the precision and clear definitions of science at one end and the always incomplete data and imprecise solutions of history on the other when the bridge is soundly linked at both ends.

For that reason most historians of science affiliated with science and engineering programs are able to discuss at least one area of science on a fairly advanced level. If one wants to provide students with the experience of redoing a famous discovery (see p. 44), at least to the extent that the original steps can be reconstructed from documents by a person who understands what is involved, deep understanding of theoretical structure and experimental methods is necessary. Teachers should be sufficiently familiar with standard reference works in order to quickly provide comprehensible answers to technical questions. This is more than a matter of maintaining the intellectual respect of students; the teacher must also encourage reference habits that will increase the awareness of students outside their specialities.

Living in a Science Department

Some scientists consider a historical view of their profession as a useless form of amusement, a distraction from more serious matters, or even a subversion of the single-mindedness they are convinced their students need, while others find historical investigation defensible. Many scientists are dissatisfied with the "parade of heroes" conception of the growth of science conveyed in the textbooks they use and are curious about (while often uncomfortable with) the much more complicated view of change that historians work with. Some are sophisticated students of history and eloquent spokesmen for it.

An issue that tends to loom large in scientists' evaluation of historians of science is scientific competence. It is rather common for members of the profession in science departments to teach some science courses, but it is by no means universal. The science faculty, who often influence not only enrollment but appointment and promotion, tend to be skeptical about people who have little technical knowledge of the subject whose history they teach. If, in addition, the historian of science has been infected by the belief that the only truly worthwhile kind of teaching is the training of recruits to one's own discipline, that "service courses" are disagreeable tasks to be handed on as soon as seniority allows, the result is often disaster.

Perceptive historians of science have proved their worth as colleagues in every field of science, but the opportunities vary somewhat from field to field. In some fields it is so difficult to teach depth in historical study without a very considerable command of the science that most of the historical work is avocational. Most of the courses in the history of mathematics, psychology, and some of the life sciences are taught by specialists in those fields. These traditions discourage scientists from taking advantage of the contributions that a well-trained historian of science can

make. Some historians of science have been successful at breaching such barriers. The alternative, which has often merely reinforced isolation, is to treat the positivist amateur as a hindrance whose work should be discouraged or ignored.

Programs designed especially for science and engineering students must cope with their preconceptions about history. These students are often eager to hear and argue about the most modern-sounding technical aspects of early science, which the historian's own training may have underemphasized and downgraded. They may or may not be willing to take seriously the kinds of questions that historians consider important. Generally speaking, historians of science who live in science departments are prepared to cope with this difficulty. They are often aided by scientists who played an important part in twentieth-century discoveries. Many are willing to come into the classroom and give students an idea of the personal component of scientific change.

Science and engineering tend to attract students who value problem-solving activity in which there is one correct answer. They are generally aware that most of the things human beings do are not that simple. Perceptive teaching, which does not take historical consciousness for granted or demand it from the very beginning, often starts them on the way to a comprehensive understanding of how the precise and imprecise, the clear-cut and ambiguous, are interlinked.

These are only a few of the challenges encountered by those who teach the history of science in science departments. As in history departments, the key to success has often been engagement and collaboration in common enterprise. If this has been onerous for some historians of science with an inflated view of the status of their own profession, it has provided for many others the basis for a stimulating teaching career in continued touch with the expanding frontiers of knowledge. It has, in fact, been the policy of some history of science departments to seek joint appointments with science departments as often as possible. Budgetary considerations have sometimes played a part in forming this policy, but the desirability of continued teaching and research as close to scientific practice as possible has also been a common motivation.

Another special characteristic of the historian's relation to the science department should be kept in mind. Besides frequently being a member of it, he often studies it. For a member of the profession interested in modern science, his department may serve as a nerve center from which connections can be made to new discoveries and techniques. His colleagues also provide valuable historical documents that need to be compiled. Many historians of science have established regular procedures for arranging to preserve the papers, manuscripts, notebooks, and special apparatus of eminent scientists and engineers at their institutions. Some actively seek out valuable materials in retired files of departments and sponsored research offices. Help and guidance are available to those who need it; for instance, the Center for History of Physics, American Institute of Physics, freely counsels on the archival documents of the sciences and engineering.

A growing number of historians of science have mastered oral history methods and used them to produce documents that are often rendered irreplaceable by retirement or death. Some involve students in this work, for instance at Berkeley and M.I.T. Some use has been made of oral history collection projects in teaching, although the elaborate background research and preparation required make it anything but the quick interview method that some novices expect it to be. Six hours of interviews a term is probably the average output for one-man projects when conducted according to professional standards.

Teaching Science to Liberal Arts Students Through History of Science

About the time that the center of gravity of the history of science was beginning a slow shift into history and history of science departments, it began to be used on a perceptible scale to provide science training for arts students. Among others, the Harvard General Education Program provided both a model and materials for reaching students who had been so inculcated with an antimathematical bias that they were able to deal only with a minimum of technicalities and would respond to science only when it was related to its cultural background. The strengths and limitations of a qualitative and historical approach to the subject matter of science have never been assessed to general satisfaction. Many institutions have given up this experiment. For some it never succeeded, although this may have had as much to do with the style of general education courses as with their intellectual potential. Others have taken the bull by the horns and proceeded to require more straightforward science courses (some laboratory-oriented) as the need for basic mathematical and scientific literacy has become more and more inescapable. Our investigations suggest, however, that general education science for non-scientists is alive and strong at institutions as diverse as Grand Valley State Colleges and Berkeley. In traditional teaching of this kind, there has been a considerable range of balances between history and science. The books and case studies that came out of the Harvard General Education Program incorporated a small amount of quantitative science embodied in materials that emphasized scientific reasoning. At the other end of the spectrum are textbooks that use history to make the usual materials of elementary science courses more approachable. There seems to be an increasing tendency to work toward a greater integration of the humanities and social sciences in teaching of this sort. It is a relatively simple matter to adapt case studies of the roles of science, engineering, and society in technological developments, originally compiled for other purposes.[1]

There is considerable interest in teaching science via the history of science on the part of high school, junior college, and small college instructors. Very little is being done at the moment to satisfy this need for teaching materials. To do so would not only be a useful public service; wider awareness of the historical dimension of science means more people who wish to continue exploring what historians of science teach.

Resources

Various scientific societies encourage awareness of their professional traditions by sponsoring historical activities and publications. We have already mentioned the Center for the History of Physics in New York, which, in addition to promoting archival work and oral history, prepares exhibits, collects photographs, maintains a small but useful collection of books (the Niels Bohr Library), and publishes a free newsletter. Annual meetings of the American Association for the Advancement of Science, as well as those of a great many scientific societies, include historical lectures and panels that serve as a forum for historians of science and scientists. In

[1]Professor Harvey Sapolsky, Department of Political Science, M.I.T., maintains and distributes an up-to-date bibliography of such case studies. Readers of this Report are encouraged to contribute as well as make use of it.

practically every scientific profession there is at least one journal which frequently publishes historical articles. For instance, the *American Journal of Physics* and *The Physics Teacher* are useful sources on the pedagogy of the history of physics. The "Resource Letters" of the *American Journal of Physics* are sometimes devoted entirely to a historical theme; sometimes they include historical bibliographies. The American Institute of Physics publishes both primary and secondary documents in forms designed to facilitate their use in teaching.

All this indicates that scientists, through their professional societies, have recognized the value of history and have given it both financial support and prestige. It is appropriate that historians of science are contributing to such projects as well as benefiting from them. The publications just mentioned usually welcome contributions from historians of science.

To sum up, though the professionalization of the history of science has tended to move it out of science departments, the institutional and pedagogical links remain strong in many universities and colleges. We believe that it is important to resist the pressures toward departmental isolation and rigidity in modern academia and suggest that traditional ties with science be maintained while new bridges are constructed to history, philosophy, and the social sciences.

Chapter 6

Historians of Science in Multidisciplinary Programs

It is only natural that historians of science have played a large part in the formation of many multidisciplinary programs. The unity of culture is an essential condition of their work.

Scope

PROBABLY A MAJORITY of historians of science, regardless of what sort of department they belong to, take part in some interdisciplinary[1] teaching. Many of them have personally mastered more than one discipline and frequently combine them in courses.

As an example of the interdisciplinary character of the history of science itself, the members of the Fishbein Center for the Study of the History of Science and Medicine, the graduate program at the University of Chicago, include faculty from the history of science, history, anthropology, history of medicine, biological and medical sciences, mathematics, geophysical sciences, and sociology.

It is also fairly common to see courses devoted primarily to the history of science offered as part of interdisciplinary programs. In Chapter I we referred to historians of science, particularly in history and history of science departments, taking part in and helping to plan programs in medieval studies, American studies, and so on. Such programs, often reaching large numbers of students, testify to the imagination and flexibility of those historians of science who participate. The same may be said of "Humanities and Science" double majors at engineering schools, which often offer history of science as a humanities concentration.

An example of a different kind is the group of historians of science and technology at the University of Minnesota. There is no separate department in the history of science and technology, and at present no independent program,

[1]The word "interdisciplinary," which is often used for activity of this kind, is not entirely satisfactory, since in established usage it implies cooperation rather than close collaboration in which individuals must overstep the established boundaries of their own fields.

although it is anticipated that a formal graduate program will be established in the near future. The distinctive and unique feature of the Minnesota group is that each faculty member has a formal appointment and office in a regular science or engineering department, and that the prospective program will then serve as an umbrella at the graduate level. This "hub-and-spoke" organizational model thus retains budgetary control over the various positions with the coordinator of the program, while at the same time it places individual historians of science and technology in direct, daily contact with scientists and engineers. The result has been to open up numerous channels for intellectual communication through personal interactions, the joint sponsorship of colloquia, joint supervision of graduate students, exchange lectures in undergraduate courses, and the like. In general, the model has been very warmly received by all concerned, and its success at Minnesota may recommend its consideration at other institutions.

Particular attention will be given in this chapter to a variety of programs in which people cross disciplinary barriers in order to address questions too broadly conceived to be treated adequately within the limits of any single profession. The last few years have seen a proliferation of such programs. Although they are often referred to collectively under such rubrics as "technology studies," there are profound differences in the ways they are conceived.[2] Most such programs and courses attempt to satisfy one of the most urgent needs of our time: a comprehensive understanding of science and engineering as they affect, and are affected by, society and individuality.

Some technology studies programs are oriented to teach science and engineering students about aspects of the world they will be working in. Some are so narrowly conceived as to be practically identical with systems analysis. Others aim at an overview of decisions about the use of science and technology and the values that affect those decisions. This approach, usually referred to as "science and society," looks at the entire system of society, unlike science policy programs meant mainly for students who will become planners or decision-makers. The latter usually focus on the values and priorities of the groups responsible for decisions.

Bridging the two cultures more ambitiously are programs that are as concerned with the dimension of individual experience as with social priorities. They might be described as attempts to evolve a twentieth-century version of liberal studies in which the traditional humanities, social sciences, science, and technology are integrated. Some programs of this kind are consciously conceived as liberal education — as the sort of understanding necessary for intellectual independence today, which is after all what liberal education is supposed to be about. Others are meant to prepare people for specific careers that can succeed only if social and personal factors are taken more seriously than is the norm in American professional life — for instance, careers of medical service in poor minority communities in the United States.

Modern society, unlike traditional cultures, cannot provide its members with a single vision of enduring social reality with which to define their own identities and responsibilities. Today that burden has been largely shifted to institutions of higher education. The majority who enter college are grossly underprepared to make sense of the increasingly complex world in which they find themselves. The task is large, the time short, the past apparently beside the point unless the relevance of human continuity has been skillfully taught by people whose historical curiosity does not ignore the present. Programs that strive for general education in this sense have nowhere to start but the world of today in all its experiential

[2]The reader is reminded that we often use the word "technology" in its widest sense. In fact technology studies programs often include consideration of theoretical science, as we will show below.

amorphousness, technological complexity, and sociopolitical ambiguity.

Many such programs will probably disappear as quickly as they came into being, when it turns out that willingness to incur risk has outdistanced competence, institutional commitment, or the ability to forge links to the rest of the educational enterprise. It will not do to dismiss multidisciplinary programs as a transient fashion, since there is no reason to believe that space would have been made for them in such a black period for higher education if they were not realistic responses to serious and abiding difficulties. Many more will appear and some will survive.

What Historians of Science Have to Offer and What Is Demanded of Them

The notion that side by side in modern civilization live two cultures – one whose language is numerical and the other whose language is verbal – has had enormous influence on thinking about education. It has endorsed as somehow in the nature of things an advancing mutual incomprehension, an acceptance of illiteracy with respect to the culture one does not belong to, and a redefinition of civilization in which technical instrumentality and human values have less and less to do with each other. Far from belonging to the order of nature, that gap is a human artifact. The programs with which this section is concerned are not multidisciplinary in the name of more efficient problem-solving (as some interdisciplinary programs on energy or transportation are). They are evolving because of the need to span that gap.

It is only natural that historians of science have played a large part in the formation of many multidisciplinary programs. The unity of culture is an essential condition of their work. In their undergraduate teaching, they have learned to deal with science and engineering students who want to understand how their own work is connected with the rest of human culture. They have taught humanities students how thought, values, and identity are affected by changes in the understanding of nature and in the experience of technology.

Historians of science who have reached maturity during the last decade and have experienced its stresses as facts of life can take the academic status of the history of science for granted; they define their research with very general issues in mind. Among them one sees a very widespread enthusiasm for the challenges of collaboration and cross-disciplinary study.

The necessary emphasis in this chapter is on the need for breadth, for an appetite for intellectual risk, and for the ability to serve a bridging function between disciplines. One cause of the schism between disciplines is the difference in attitude toward values. There is a widespread feeling among technical people that, when the role of values in science and technology is discussed, there can be no issue but opinion, and, as everyone knows, one person's opinion is as good as another's. What historians of science have to contribute is a critical view of the causes of change. The role of science both in changing attitudes and in affecting material well-being has to be studied historically if students are to move beyond opinion to be aware of what they understand and what they do not understand about values.

It is difficult to believe that a historian of science can survive the special stresses and risks of multidisciplinary teaching unless he or she has a knowledge of some science and a sound command of historical method. Many problems that can

be defined within the traditional limits of the history of science itself can be dealt with adequately or even brilliantly by people with partial backgrounds, but work with colleagues from a variety of disciplines requires both greater ability to hold one's own on broadly defined issues and greater confidence in finding common foundations for discourse.

Examples of Programs

1. Program in Health, Medicine and Society, City College, CUNY, New York. This is an undergraduate major designed to meet the needs of urban minority students who will be involved in the administration and distribution of medical and general health services. Its courses also serve students with a general interest in health, premedical, and nursing students. Practicum courses and field work provide the opportunity to work under supervision in hospitals and community health facilities. The program is part of the Center for Biomedical Education, and the part-time faculty includes physicians and social scientists as well as representatives of Black studies, Puerto Rican studies, Jewish studies, and Asian studies. The chairman is a historian of science by training.

2. The Technology and Society Program, Babson College. This small school of management offers a series of liberal arts courses in Society and Technology and several general science courses; the aim is to inform the future manager of the principles of science and technology and to help him or her understand them as a cultural phenomenon. The director is a historian of science by training.

3. Humanistic Perspectives on Technology, Lehigh University. A developing program of courses, seminars, and lectures meant for a diverse student body and ultimately intended to enter the mainstream of undergraduate education. A special feature is workshops for faculty and students (at a one to two ratio) for planning courses and curricula and compiling bibliographies. A minor is now offered, and an undergraduate major is projected. In addition to academic offerings, the program sponsors community events to disseminate information and illuminate technology and human values. Part-time faculty.

4. Humanities, Science and Technology Unit of the Program on Science, Technology and Society, Cornell University. This Unit is strongly oriented toward research in which humanistic insight and method are applied to resolve pressing social problems, especially those due to the growth of science and technology. A major interest is problems connected with rational decision-making. Another is problems in biomedical and environmental ethics. There is no integrated teaching program, but historians of science associated part-time with the program have taught courses growing out of their research on such topics as the history and philosophy of biology and science as portrayed in literature.

5. Education and Experience in Engineering (the E^3 Program,), Illinois Institute of Technology. An experimental four-year program for a limited number of students self-selected from a student body of largely working-class backgrounds. Training is through a succession of projects for which student working groups are responsible from conception to completion of the final report A humanities or social-science faculty member and an engineering faculty member participate in each working group. Backup technical training is provided through self-paced learning modules and seminars of limited duration.

6. The Collegiate Seminar Program ("Strawberry Creek College"), University

of California, Berkeley. An experimental, limited-enrollment program of small interdisciplinary seminars for freshmen and sophomores at a large liberal arts university. The program provides a self-sufficient lower-division program with its own faculty. Although it is intended as an alternative program for students primarily oriented towards the humanities and social sciences, there is considerable stress on natural science as it affects human and social questions. The seminars focus on relatively new and unexplored problems rather than on disciplines, but the teaching of each is shared by instructors from more than one field. Last year a visiting historian of science collaborated in teaching a one-year seminar on "The Technological Culture," which dealt with issues from Renaissance magic to social and political implications of current science.

7. A course entitled "Socio-technical Problems of American Society: Energy," Department of Social Sciences, Georgia Institute of Technology, is directed toward making undergraduates in science, engineering, and management aware of the social, political, economic, and human problems involved in "the technological fix." The course is collaboratively planned and taught by people from history of technology, philosophy of science, economics, political science, nuclear, chemical, and systems engineering, decision theory, and architecture. In addition, a full range of courses at the undergraduate level in the history and philosophy of both science and technology is offered.

8. Technology Studies Program, M.I.T. A multidisciplinary humanities program of research and undergraduate teaching of science and engineering, also planning a post-doctoral component. It now offers a first approximation to a coherent series of courses for technology undergraduates and a very few humanities concentrators. The program is collaborating with the science and engineering departments to raise the quantity and quality of humanistic courses they offer. Its faculty includes three historians of science, one political scientist, one physicist/economist, one aeronautical engineer, and one nuclear engineer. Other multidisciplinary programs at M.I.T. in which historians of science have taken part in the last academic year include Concourse, a highly structured and topically organized program that teaches the entire freshman-year curriculum to fifty students without reference to the conventional departments of knowledge (except for separate sessions on certain skills), and the Experimental Studies Group, a barely structured program in which a small part-time staff arranges individual curricula with fifty freshmen.

9. Cultural and Technological Studies, University of Wisconsin – Milwaukee. A developmental undergraduate teaching program with campus-wide support and enrollment, it offers undergraduate courses from widely varied disciplines on the relationship between technology and values. Senior courses focus on the responsibilities of professionals as agents of social change. Core faculty in history, philosophy, anthropology, political science, and literature teach two thirds of their courses in the program. Associate faculty teach one course a year on released time, using their expertise to focus on the interface between technology and culture.

10. College of Thematic Studies, University of Pennsylvania. A long-established collection of three-course programs (e.g. Utopias, Women's History, Science and Society) staffed by faculty and graduate students from a variety of liberal arts departments and professional schools, with minimal hiring and expense. The History and Sociology of Science Department plays a regular part in these "modules," and in 1974-1975 designed the central unifying course in Health and Society as well as doing a regular course.

These examples illustrate the breadth of a movement that is just gaining

momentum – a movement which is developing structures for communication between programs as quickly as they themselves evolve. Innovative multidisciplinary programs are found in institutions whether public or private, whether wealthy or living hand-to-mouth, whether those with many students who aim for the professions or those with few.

Historians of science are increasingly working in institutions where there can be little or no demand for large-scale programs in the history of science itself. Ability and willingness to engage in interdisciplinary and multidisciplinary teaching may be the alternative to a frustrated sense of professionalism. Such teaching may mean a chance to apply one's training to urgent and interesting issues, a basis for collaboration with outstanding people in a number of fields, and wide, well-informed support for tenure among faculty and students.

What then do technology studies have to offer poorly funded institutions or those mainly concerned with vocational education? Every college or university must balance risk against the need to educate critical awareness in every student. It is not beside the point that outside funding for experimental teaching in urgent directions is increasing. There is a general desire on the part of both private and public funding agencies to underwrite more experiments at institutions of kinds that are seldom heard from. Most of the major public and private foundations with interests in technological education are already involved in funding multidisciplinary programs of the kinds described above. Institutions that recognize the need and want to do something about it may find an exceptionally qualified historian of science to plan, seek funding for, and draw together the operation of a technology studies program that meets its needs.

Sources of Information About Interdisciplinary Programs

Historians of science involved in planning can count on a great deal of help. The mushrooming of technology studies programs has been accompanied by a proliferating communications network. Among the organizations that supply information are the Program on the Public Conceptions of Science at Harvard University and the Ethical and Human Value Implications Program of the National Science Foundation. The latter also funds educational projects. The Harvard program publishes and distributes without charge to interested persons a quarterly newsletter with information about activities and resources pertaining to the ethical and human value implications of science and technology (as well as current annotated bibliographies and other useful materials). Most programs in the technology studies field freely distribute their own brochures and reports.

What the History of Science Profession Can Contribute to Multidisciplinary Teaching

In the light of new patterns of employment that are gradually becoming apparent, it is reasonable to suppose that in the future more historians of science will cross the borders between the traditional disciplinary humanities and technology studies in their teaching. The character of the discipline makes their training particularly useful in such applications. Members of the profession have already played a notable part in founding such programs, participating in them, and reinforcing the humanistic commitments of scientists and engineers in collaborations that have led to them.

Enhanced ability to play such roles should be a conscious aim of graduate training. In addition to a speciality, programs for training Ph.D's in the history of science usually involve general competence in isolating issues and controlling the literature on any topic of interest. This makes it possible in principle for any member of the profession to become involved sufficiently in research on current issues to teach about them competently. But whether one gets a head start on such involvement in graduate school, where time is available to lay foundations for subsequent work, is left to individual inclination. Few students are actively encouraged by their teachers to work their way into multidisciplinary topics. It is not surprising that after graduation most, feeling unprepared, are reluctant participants. But as more members of the profession decide to take part in multidisciplinary teaching, and they find themselves ready to write books about their least specialized research – especially the research that has borne fruit in the classroom – it is likely that the history of science will gain immense influence on the current intellectual scene.

Chapter 7

Graduate Training for Undergraduate Teaching

Since historians of science are increasingly seeking jobs in schools primarily oriented toward undergraduate education, and since there is growing emphasis in that direction in the universities, there are more and more practical reasons for instruction on teaching.

WITH A VERY few exceptions, history of science departments that award the Ph.D. also teach undergraduate courses. Their strengths, styles, alliances, and difficulties are so diverse that it would be of little use to generalize about their undergraduate programs. No single pattern in the undergraduate audiences of history of science departments is apparent. Departments draw both science and engineering students and history students in varying proportions. In universities where preparation for medical school is stressed, departments tend to find a strong constituency among premedical students. Our informants agree that the relationships cultivated with other departments play a nearly determinative role both in the balance of student interest and in the department's involvement in multidisciplinary programs and experimental units. There is equal diversity in institutional relations with the history of technology and the history of medicine. One finds departments of the history of science and technology and departments of the history of science and medicine, although departments of the history and philosophy of science are much more common. Many history of science departments without further specification in their titles include faculty members whose specialties are medicine or technology. At the University of Wisconsin (Madison), history of science, history of technology, and history of medicine are independent programs.

Although more might be said about undergraduate programs in history of science departments, limitations of space force us to move on to the question of preparing scholars to teach undergraduates. The emphases of various departments and the specialties of their faculty members have already been conveniently reviewed in Schallenberg, "A Guide to Graduate Study and Research in the History of Science, Technology and Medicine."

Training Graduate Students to Meet New Opportunities

The great growth in history of science departments in the 1960's made it relatively easy for them to react to the new demands of the time. These demands, as we noted in Chapter 2, were largely for people with clear-cut specialties within the history of science, oriented toward serving in history of science programs.

It is vastly more difficult to meet the more varied and less clearly defined demands of today's academic world. Many faculty members at all levels of seniority have chosen to extend their research and teaching interests. Many are taking a larger part in undergraduate teaching at those institutions where graduate students are (or were formerly) given greatest priority. Some programs have managed to keep growing and evolving flexible formats to meet new undergraduate needs. Nevertheless, we have a clear impression that graduate students as well as undergraduates want more work on twentieth-century science and on the social and political backgrounds of science than is easily available to them.

In most universities, graduate students who want to can find some opportunity to study the history of modern science, but we believe it is considerably more difficult than it might be for graduate students to prepare for a career of teaching and research in all of the major dimensions of modern science and technology.

It might be objected that preparation for creative academic work of any kind is largely sink or swim. That is a perfectly reasonable answer, but not a very productive one. Furthermore, it pays no attention to certain ironies. For instance, several history of science departments, because they are strong in renaissance studies and encourage collaboration with anthropologists, prepare their students to do very sophisticated teaching in the history of occultism, while their graduates who wish to prepare a course on science and society in the United States lack adequate help.

What might be done to provide better training in these recently prominent aspects of the history of science, at a time when it will not only satisfy the desires of graduate students but make them eligible for more jobs? In particular, what can be done by present faculties, under present financial conditions, and without seriously weakening work on well-established subjects?

More Ph.D. programs might want to consider an oral examination field in social, intellectual, and value contexts of modern science and engineering. This opportunity (ideally a requirement) would necessitate enlisting the cooperation of social scientists as well as scientists and engineers – a move potentially beneficial in many ways. A comparatively efficient way of providing students with tools for research and teaching would be a required seminar devoted to methods of research in the interdisciplinary history of science and technology. Once students are aware of the great number of research aids that have recently become available, they will be much better prepared in their undergraduate teaching to explode the myth that a historian cannot understand the present day as well as he can comprehend the Middle Ages.

Although twentieth-century science is a topic much talked about, there is much that can be done in graduate education in established areas of study that can improve the students' preparation for undergraduate teaching. The background that a graduate student must have in Greek science, medieval science and technology as well as in the Scientific and Industrial revolutions can be considerably enhanced by study of the social, economic, or political history of those periods. Familiarity with one or more of the historical specialities outside of the history of science will enable the graduate to initiate cooperation with other historians. A specialist who can demonstrate that there are natural ties with other specialities in the history department will have an advantage when interviewing for a new position, and her or his value to the department will increase with experience.

Since historians of science are increasingly seeking jobs in schools primarily oriented toward undergraduate education, and since there is growing emphasis in that direction in the universities, there are more and more practical reasons for instruction on teaching. Our survey of the major graduate programs in the history of science (incomplete but not narrow) indicates that in not a single one does a faculty member of the history of science program regularly supervise teaching by graduate students. None has a regular program either of pedagogical training or evaluation by department faculty. We did not hear of a single program that as a matter of policy urged its teaching fellows to take advantage of facilities established at their universities for the improvement of undergraduate teaching. Some faculty members feel that not much practical aid would be available from the school of education at their university, but few know exactly what their schools of education are doing in this line. Nor is systematic use made of centers designed for the purpose and widely reputed, such as the Bureau of Study Counsel at Harvard and the Center for the Improvement of Undergraduate Education at Cornell. Graduate students we have spoken to express the need for help in teaching, but report little interest on the part of most departmental faculty. In discussions with faculty members we have encountered with some frequency the conviction that good teachers are born and not made, with the corollary that explicit attention to pedagogy is a waste of time. Certainly there is always an element of personality in teaching, and no short course can possibly produce uniformly competent and poised teachers. But departments who are led by this reasoning to do nothing at all will, we are convinced, be making their graduates somewhat less employable. Pedagogy is commonly a matter of stress for graduate students, just as for young professors, precisely because much is demanded but little is taught about it.

What can be done, then, without major departures of a kind that few departments are prepared to contemplate? The primary step would seem to be an assumption of responsibility. Graduate departments might consider designating one faculty member or a small committee to provide students with orientation in the organization of teaching; effective classroom conduct; shaping classroom situations that encourage participation and cooperation; evaluating the backgrounds, capacities, and motivations of students; dealing constructively with difficulties such as failure of students to prepare for class, interpersonal blocks, fruitful discussion, fair grading, and so on. A seminar of this kind would be of benefit even to students who do not have regular teaching responsibilities. The latter might be offered an opportunity to run one or two sessions of a course. Observation of teaching performance can be based on audio-tapes or videotapes as well as on visits. The chance to view a videotape of one's own teaching performance (especially if the facial responses of students are included) is one of the most potent ways there is to evaluate one's own teaching and to minimize bias in discussion of it.

Many faculty members will feel reluctant to undertake such a responsibility. Actually it is far simpler than most people suppose to pool a good deal of experience. That is what centers for undergraduate teaching set out to do. Some of them (such as the two mentioned earlier) freely provide materials and guidance to faculty members at other institutions that do not have such centers.

Our point in this section is merely that there are useful things to be done with minimal time and money, and that these priorities are worth serious consideration by programs that choose to meet new opportunities for growth.

Chapter 8

Curriculum Materials

One reason for this lack of comprehensive introductory books is the organization of graduate faculties according to traditional disciplinary lines: the history of physics, biology, chemistry, etc. But because the undergraduate curriculum does not typically allow such differentiation for many students, it may be hoped that authors find the means to make their offerings more comprehensive.

UNDERGRADUATE TEACHERS of the history of science and technology today face a simultaneous wealth and poverty of course materials. There are many outstanding works, but there are also many topics and periods for which nothing introductory can be found. The purpose of this section of the Report is to acknowledge the availability of many fine selections, to suggest where there are deficiencies, and to recommend steps the Society might take to remedy them.

Texts Suitable for Undergraduate Instruction

Before referring to works by individual authors, mention should be made of two recent cooperative efforts, the *Dictionary of Scientific Biography* and the *Isis Cumulative Bibliography*, which have made the field more accessible to undergraduate teachers and students alike. Another recent effort of multiple authorship, cooperative in a different sense, is the Bobbs-Merrill History of Science Reprint Series edited by Theodore M. Brown and Thomas S. Kuhn. The ninety-five articles in this series enlarge the instructor's choice for reading assignments and offer the student convenient access to significant scholarship.

A recent series of book reprints is *History, Philosophy and Sociology of Science: Classics, Staples and Precursors*, edited by Yehuda Elkana, Robert K. Merton, Arnold Thackray, and Harriet Zuckerman, published by the Arno Press. Also cooperative in origin is the pamphlet on the History of Science by Marie Boas Hall. It appeared in the series published by the Service Center for Teachers of History

established by the American Historical Association. Although published in 1958 and hence out of date, it has not yet been supplanted.[1] Another and exceptionally usable source is the topically indexed bibliography on science policy published by the American Association for the Advancement of Science.[2]

Among recent works by individual authors an encouraging number have been directed to undergraduate readers. The Wiley series, edited by George Basalla and William Coleman, is explicitly "dedicated to bringing the history of science to a wider audience." So far it includes a work on medieval physics by Edward Grant, *Physical Science in the Middle Ages* (New York, London, Sydney, Toronto, 1971); one on seventeenth-century science by Richard Westfall, *The Construction of Modern Science, Mechanisms and Mechanics* (New York, *et al.*, 1971); another on nineteenth-century biology by William Coleman, *Biology in the Nineteenth Century. Problems of Form, Function and Transformation* (New York *et al.*, 1971), and a new volume by Garland E. Allen, *Life Science in the Twentieth Century* (New York *et al.*, 1975). This series is especially strong in analyzing the intellectual component of the history of science. In orientation the Wiley series thus joins the three volumes by the Nuffield Unit for the History of Ideas in the early 1960's.[3] One could now wish for similar attention being devoted to the institutional development of science.

In addition to cooperative efforts, many single works by professional historians of science could be cited. There are also numerous works by scientists themselves, such as the perennially popular *The Evolution of Physics* by Albert Einstein and Leopold Infield, (new ed., New York, 1960), and the recent spate of books on twentieth-century genetics. Moreover, historians have contributed books essential for undergraduate teaching: one need only mention Sir Herbert Butterfield's *The Origins of Modern Science* to document this claim.[4]

Despite the abundance there is also poverty. The most glaring deficiency from the instructor's point of view is the unavailability of many titles. Classics published in hard cover such as Erik Nordenskiold's *The History of Biology* (translated by L. Eyre, New York, 1928) and Charles Singer's *A Short History of Science* (Oxford, 1931), have been out of print for many years. The situation for books published in paperback is hardly better. Fine titles are dropped every year. Because of this yearly loss, the selection available for course use is not cumulative. How does one balance the loss of Max Casper's biography of Kepler, recently dropped by Collier, against the gain of a new title?

The range of offerings in print depends largely on the profitability of various titles to their publishers. It is consequently beyond the control, and probably even the influence, of the Society. In the opinion of the Committee, however, certain works, particularly primary sources, are of sufficient importance and brevity for the Society to take an interest in their constant availability. Recently, for example, Gateway Editions (Henry Regnery Company) dropped its inexpensive ($1.45) edition of William Harvey's *On the Movement of the Heart and the Blood in Animals*. The work is now available only in a considerably more expensive edition.

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[1]Copies of this pamphlet are still available. For more information write: American Historical Association, 400A Street S.E., Washington, D.C. 20003.

[2]Felicia E. West, ed., *Science for Society: A Bibliography* (5th ed., Washington, D.C.: A.A.A.S., 1975). Copies are available for $2.00, including postage, from A.A.A.S., 1776 Massachusetts Ave., Washington, D.C. 20036, attention Ms. Rosetta Price.

[3]June Goodfield and Stephen Toulmin, *The Fabric of the Heavens: The Development of Astronomy* New York, 1961); The Architecture of Matter (New York, 1962); and The Discovery of Time *(New York, 1965).*

[4]Herbert Butterfield, *The Origins of Modern Science* (New York: Macmillan Free Press Paperback, 1965).

The Committee recommends that the Society attempt to find and establish cordial relations with publishers willing to stock books of the first importance over a long period. More than cordiality would be required, of course, to make such a program workable. If an early warning system were set up to bring in information about what books were likely to be discontinued because of lagging sales, however, it might not be inappropriate to convey news of this kind in the *Newsletter* and let faculty members make their own arrangements to avoid disappointment. Either an arrangement of this kind could be carefully planned to avoid serving as an advertising medium, or it might be desirable to run such notices as small and inexpensive paid advertisements (in which case room might be made for them in *Isis*). The point is to make it feasible for publishers to expect a continuing market.

In cases where demand would be too limited from the start, the Committee recommends that where necessary the Society itself consider publishing certain works, such as translations of short texts, which may be of use to those teaching undergraduate courses. The scale and style of such publication could be modest in the extreme and distribution nonprofit. For fifteen years the Association of Asian Studies has sponsored reprinting on an enormous scale and publishing of specialized material on a small scale through a nonprofit wholly-owned subsidiary (Chinese Materials Center, Inc.).

A second deficiency, made more glaring by inconstant supply, is the small selection of general books in the field. There is, at the moment, no single work which is introductory both in the sense that it presumes no previous knowledge of the subject and in the sense that it portrays the field in its entirety. There are a few books presently in print which do one or the other. For example, Thomas S. Kuhn's *The Copernican Revolution* (New York, 1959) is introductory in the first sense. It fully explains in both words and diagrams, the fundamental points at issue and thereby prepares the student for further work in the history of planetary astronomy. Although written for high school audiences, Asger Aaboe's *Episodes in the History of Mathematics* (New York, 1963) is another work of this type. A similar introductory work in the history of genetics is John A. Moore's *Heredity and Development* (2nd ed., New York, 1972), intended for biology students.

An example of introductory works of the second, survey text type now in print is Stephen F. Mason's *A History of the Sciences* (New York, 1966). While Mason's book is nearly twenty years old, it has not been replaced, no doubt partly because of the inherent difficulties of accomplishing the task within the limits of one volume. Despite the difficulties, however, Mason succeeded in providing a coherent narrative describing the major areas of scientific accomplishment from the Babylonians to the present. The comprehensive nature of Mason's text conveys to the student a sense of the long development of the sciences, a sense which is impossible to present in a more narrowly focused work. But its lack of diagrams and illustrations, as well as the necessarily sketchy treatment of substantial problems, prevent the book from being wholly satisfactory as an introductory text. What is needed perhaps is a balance between the broad scope of Mason's *History* and the explanatory integrity of Kuhn's *The Copernican Revolution*. Such an approach might yield a work considerably longer than either of those cited. Greater length is not in itself prohibitive, since many texts to which students are accustomed in other fields run to several hundred pages.

One reason for this lack of comprehensive introductory books is the organization of graduate faculties according to traditional disciplinary lines: the history of physics, biology, chemistry, *etc.* But because the undergraduate

curriculum does not typically allow such differentiation for many students, it may be hoped that authors find the means to make their offerings more comprehensive.

In connection with increasing the influence of the history of science upon general history, we have already urged that the Society encourage and recognize books written for a general audience. Considering the future of the profession, the Committee believes that establishing solidly based introductory courses for undergraduates is essential. Books of this kind not only provide the student with appropriate reading but are helpful to instructors, especially those teaching in isolation from professional colleagues, in preparing courses. It is for this reason that we have urged an annual prize for a book suitable for use in undergraduate teaching – although we hope this will not be the book's only use.

As a footnote to this recommendation, we remind the reader that the Committee has chosen to refer specifically to the undergraduate audience whose interests it represents. This was thought to be a necessary specification because there is a tendency when specialists write books for a wide audience to give free rein to narrow concerns. The result is a book accessible to a smaller and more mature readership than the author originally intended. This happened, for example, with the series of pamphlets published by the Service Center for Teachers of History. This series was designed explicitly for the use of teachers of history in secondary schools; in fact, as its sponsors have admitted, the series is more appropriate to the needs of graduate students. Different canons apply to works intended for different audiences. Originality, accuracy, and seriousness of the problem determine the worth of a work addressed to other professionals. Qualities such as scope, sufficiency of explanation, and comprehensibility are more appropriate measures of a work intended for the undergraduate. Therefore, should the Society choose to establish an award recognizing works useful to undergraduates, the Committee recommends that care be taken to insure that only the appropriate canons be used in judging those works.

Audio-Visual Aids

There are a number of other aids to the study of the history of science and technology. Laboratory courses in the history of biology have been organized at SUNY at Stony Brook and at Boston University. A historical physics laboratory at Barnard College serves both elementary and advanced undergraduates. Since such courses require special materials, they could lead eventually to the design and marketing of equipment useful to the study of the subject – replicas of astrolabes for laboratory courses in the history of astronomy, *etc.* While the danger of gimmickry is always at hand, the history of science naturally lends itself to means of expression beyond the written word.

For the moment, however, the prime materials available for classroom use besides books and reprints are audio-visual. Here too the instructional potential of such media has not been gauged. For example, in the judgment of one knowledgable critic, but a single worthwhile film has been made on the history of science, that on William Harvey commissioned by the Royal College of Physicians some years ago. If few films approach the quality of the first-rank books in the field, the potential utility of the medium should encourage the Society to recognize those at work in this area and, where possible, forward their efforts. But criteria for judging films for classroom use would have to be established. Fortunately, good catalogs of films pertaining to science and its history are published or in the

process of being published. A large catalog listing educational science films suitable for all grade levels from elementary school through college has recently been published by the American Association for the Advancement of Science.[5] A list of films pertaining explicitly to the history of science has been compiled by Bruce Eastwood.[6] A short guide to films in the history of science has already been published in Canada.[7] A catalog of rental films distributed by the Museum of Modern Art (11 West 53rd St., NYC) lists a number of excellent low-cost films, *e.g.* John Grierson's 1933 documentary *Industrial Britain* for $25. For the teaching of history through film, two publications also provide substantive help: *Teaching History With Film* (American Historical Association, 1974, $1.00), and *Film and History*, a quarterly publication ($5.00 per annum) of the Historians Film Committee (The History Faculty, Newark College of Engineering, Newark, New Jersey 07102).

Films can, of course, be used to document as well as illustrate. This is particularly true for the history of technology, and several historians are already using film successfully for both purposes. While the use of film as document for research leads beyond films designed for educational purposes, the experience of teachers who use film in the classroom has shown this to be an advantage. No "educational" film, for example, has the power of the great and easily available documentaries of the 1930's such as *The Plough That Broke the Plains* in dealing with American agriculture during the depression. Nor are changing public attitudes towards science better displayed anywhere than in science-fiction films, from George Melies' *Trip to the Moon* (1902) to H.G. Wells' *Things to Come* (1936) and on down. Those intrigued by this approach may be directed to a forthcoming paper by John Weiss of Cornell University entitled "The Eyes of Prometheus: Film as a Source for the Study of the Historical Relationship between Technological and Social Change."

The last fifteen years have seen the production, at least in Britain, of a number of important films. For example, the series of books by Toulmin and Goodfield was accompanied by four films. More recently on a larger scale Jacob Bronowski's series of thirteen films titled *The Ascent of Man* has been released by Time-Life, though at prices for the series ($1,000 rental, $7,800 purchase) which will be prohibitive for most schools. Criticism being the handmaiden of publicity, it must be allowed that neither the Toulmin-Goodfield nor the Bronowski series finds its most natural audience in the college classroom. The approach of both is panoramic rather than analytical and thus more suitable to television. To say the Bronowski films are best suited for television is not to be condescending: Jacob Bronowski has done more to create a mass audience for the history of science than any academic historian. It is to say that some films lend themselves to one kind of audience more appropriately than to another.

A series that is more easily compatible with the usual classroom format is produced by Britain's Open University and marketed in the United States by Harper-Row. The segments of the Open University curriculum dealing with the

[5]Ann Seltz-Petrash and Kathryn Wolff, *A.A.A.S. Science Film Catalog* (New York: A.A.A.S. and R.R. Bowker, 1975). The catalog is available for $16.95 from R.R. Bowker, P.O. Box 1807, Ann Arbor, Michigan 48106.

[6]Bruce Eastwood, *Introductory Guide to Audio-Visual Materials for the History of Science and Technology.* Publication is in the process of being arranged. Interested readers should write to Professor Eastwood (Department of History, University of Kentucky, Lexington, KY.) for further information.

[7]*Films on the History of Science* (Ottawa: Canadian Film Institute; National Science Film Library, 1972). The pamphlet is available from the Institute for $.75, including postage.

history of science and technology are relatively narrowly focused and well suited to the American classroom. For example, one half-hour film in the series is devoted to an explanation of the work of Humphry Davy. This approach may be contrasted with that of one film listed in the Eastwood *Guide*, which covers the entire history of electricity in eleven minutes.

A less expensive avenue for the development of audi-visual materials is slides and transparencies. Several rather ambitious projects have been completed using slides, such as the series in the history of technology published by a Texas group for Research in Literature and Industry.[8] These projects are listed in the Eastwood *Guide*. In addition, individuals within the profession as well as university departments have developed their own slide libraries, and the Committee hopes that persons and departments will find it possible to exchange their collections with each other.

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[8]Research in Literature and Industry
5622 Dyer Street, Suite 108
Dallas, Texas 75206

Chapter 9

Recommendations

OUR MOST GENERAL recommendation is that increased consideration be given to interdisciplinary and multidisciplinary teaching and to closer links with other disciplines. Our motivation is not expansion for its own sake, but a conviction that the history of science has demonstrated its ability to meet many of the urgent needs of modern education, and that those who are willing to labor in this direction should have as much encouragement and support as more traditional activities have been given. We wish also to draw together in this section some of the specific recommendations that we have justified in the body of this Report. All of them are aimed, directly or indirectly, at enhanced involvement of historians of science in all the varieties of undergraduate education.

Some of our recommendations below can be carried out more or less wholly within the purview of the History of Science Society. Some require that the Society urge others to consider some action. These are not matters in which coercion would be desirable even if it were possible. What we suggest are means to ends that will be desirable and feasible for some and not for others.

The Committee on Undergraduate Education recommends that the History of Science Society undertake to:

1. encourage consideration by graduate programs of further steps to prepare future Ph.D.'s to meet the diverse needs of undergraduate education in a broad spectrum of institutional situations.

2. encourage historians of science to work toward a better-informed public as a foundation for an expanded undergraduate response in the future. We suggest more involvement in secondary school teacher training, college teacher training, adult education, and the continuing education and retraining of scientists and engineers.

3. sponsor and encourage production and distribution of aids to more broadly conceived undergraduate education:

   a. sponsor compilation of a selected and annotated bibliography for undergraduate reading in introductory courses of all kinds. Such a bibliography should include not only textbooks but also introductory works written for a general audience.

   b. encourage and recognize by an annual award distinguished writing meant

for a general audience and suitable for use in introductory history of science courses. Another move toward the same end would be use of the Society's *Newsletter* and, when appropriate, *Isis*, to better inform members about trends in publication. The Society is also urged to consider the possibility of an annual award, or some suitable form of annual recognition, for the best new audio-visual material suitable for use in undergraduate teaching.

c. work out means of urging publishers to keep books useful for undergraduate courses in print and explore the possibility of undertaking the inexpensive publication of sources and other materials that would not be commercially feasible.

d. appoint a group to organize and operate a profession-wide video-tape lecture-discussion exchange. It is often possible to extend the subject matter of a course when a visiting expert in a field complementary to the instructor's is available. We suggest that the drastic curtailment of expenditures for visitors in the last two or three years can be compensated for, at least partly, if videotape is carefully used. The topics might be any on which there are comparatively few specialists in the profession. One might tape a fifty-minute session with a small number of students who are novices in the field and had been given an average reading assignment for orientation. The faculty member would respond to the questions that the assignment suggested to the students. An instructor somewhere else, before showing the videotape, would make the same advance reading assignment, so that many of the same questions would be in his own students' minds. Experiments have shown that the topics discussed in a session of this kind tend to be somewhat more general in nature than the reading assignment, and that students tend to carry away more than from the usual packaged television lecture.

4. take additional measures to keep members of the profession informed on matters that affect undergraduate teaching, directly and indirectly. Thus in addition to curriculum and pedagogy, we suggest that attention be paid to such topics as linkages with other disciplines and the undergraduate teaching needs of various kinds of colleges and universities. These ends can be pursued through various means:

a. panels at annual meetings of the History of Science Society. The main function of annual meetings has been to serve as a forum for reports on research, so that members of the Society may keep informed of current trends. The Society has also devoted panels to interdisciplinary topics and to undergraduate teaching. We do not believe that these themes need take up a much larger portion of annual meetings than in recent years, but they should be planned for maximal effectiveness. It may be necessary, for this reason, to work out a set of guidelines to be used and disseminated by program chairmen. We have in mind three types of panels, each with its own requirements:

i. annual sessions on undergraduate teaching. At the 1973 and 1974 annual meetings, the Committee sponsored sessions on teaching. Evaluating these efforts, we find them far from satisfactory. We have been greatly aided in rethinking this problem by intensive discussions at the Conference on Undergraduate Education (sponsored by the Sloan Foundation) at Iowa State University, Ames, 19-20 May 1975. At that conference we learned that what people hope to gain from meetings on teaching is mainly information about what other people are doing and what their experience has been. Long papers and short discussions have not turned out to be productive. We therefore

propose that future meetings on teaching take the form of a round table in which all of the participants are encouraged to describe their own experience on a set topic. For example, the topic we have chosen for the 1975 annual meeting is "What Role Does the History of Technology Play in Undergraduate Teaching of the History of Science?" Such meetings will convey to each person present a great diversity of experiences, and a summary of information, generalizations, and principles likely to be of wider interest can be published in the *Newsletter*.

ii. a meeting at which scholars from different disciplines present short papers on the same research topic, with considerable time for discussion of differences in viewpoint and methodology.

iii. an occasional panel on pedagogy. The panelists might include educational evaluators, one or two historians of science with special experience in various kinds of pedagogy, graduate students, and undergraduates. Instead of prepared papers, such a panel might comment on a loosely defined topic or simply discuss questions from the floor. Again they should be used to exchange the fruits of experience rather than to define set positions.

b. a new committee or task force of the History of Science Society to form a more detailed critical picture of links to other disciplines (history, sciences, social sciences) than it has been possible for us to do. Such a group might be directly charged both with informing the Society and with recommending measures to improve interdisciplinary relations.

c. an improved information base for further studies of trends. The Society has for some time taken the responsibility for gathering information about its membership and has provided (through the considerable voluntary efforts of individuals) informative discussions of employment trends. We suggest, by way of minor improvement, that the form used to solicit information for the *Directory of Members* be revised to ask specifically for designation of higher degree and department of a faculty member.

5. We also urge that a new committee be appointed to study historians of science outside academic life and (among other aspects) their direct and indirect contributions, now and potentially, to undergraduate education. A considerable portion of the Society's membership is composed of nonacademics. They include journalists, physicians, rare book dealers, amateurs, and civil servants. That much we can say, but it would take a considerable effort to construct a balanced picture of what they do, what their contribution to the history of science has been, what the value of their training has been to them, how their needs might better be anticipated in early education, and what they might be willing and able to contribute to the public and academic support of undergraduate instruction in the history of science. A committee composed of non-academic members of the Society should be able to perform this task with distinction. We believe that its possible value as a precedent for academic professions similar to the history of science can be used to justify outside funding.

6. We recommend that the Society establish a standing committee on undergraduate education.

Appendix I

TABLE I **Degree Subjects of Faculty and Graduate Students Now in History of Science**

	Faculty			*Graduate Students*	
	Percent of:			Percent of:	
Subjects	BA or BS (N = 62	MA or MS 43	PhD 74)	BA or BS* (N = 123	MA 56)
History of Science, technology or medicine; philosophy of science	8	14	45	14[9]*	43
History	10	12	15	14[16]	5
Philosophy	13	12	7	10[6]	5
Mathematics, physical sciences, engineering	52	37	20	41[41+]	25
Biology, medicine	11	14	9	9[7+]	13
Behavioral/social sciences, education, library	5	7	1	5[12]	7
Humanities other than history, philosophy	5	4	3	7[2]	2

*Numbers in brackets are percentages reported in the survey by French & Gross, *Science Studies* 3(1973), 161-179, based on 76 respondents. The numbers "41+" and "7+" signify that the 7 percent of their respondents who listed "other sciences" should probably supplement the numbers in physical and biological sciences.

NOTE

From "Education of Historians of Science in the USA" by S. G. Brush (survey for IUHPS, 1973-74) to be published in Synthesis (1975).

TABLE II

Degrees in the History of Science Awarded by History and Philosophy of Science Programs in the United States and Canada

	Ph.D's	*Terminal Masters*
1968	29	12
1969	29	6
1970	32	19
1971	37	12
1972	36	24
1973	33	17
1974 (predicted in 1973)	27-29	9-10
1975 (predicted in 1973)	24-25	5-6

NOTE

From Richard H. Schallenberg, "Second Annual History/Philosophy of Science Employment Survey" (unpublished, 15 December 1973), pages 1 and 2.

TABLE III

Professional Identifications of Members of the History of Science Society Who Are Faculty Members in U.S. and Canadian Colleges and Universities

History of science	41%
Science	32%
History	10%
Fields related to history of science	16%

NOTE

These figures represent 358 persons, or 59.4 percent, of those from whom questionnaires were received. The questionnaires were sent to the entire U.S. and Canadian membership of the History of Science Society, or 1240 people, and 603 were returned. From R. Judson Carlberg and Robert E. Snow, "The 1972 History of Science Survey." History of Science Society Newsletter, November 1973, page 22.

TABLE IV

Departmental Affiliations of Members of the History of Science Society Who Are Faculty Members in U.S. Colleges and Universities

Departments of the History of Science or Medicine	16%
Department of Science or Medicine	42%
Departments of History, Humanities, etc.	32%
Departments of Philosophy and Philosophy of Science	9%
Departments of Engineering	1%

NOTE

Note that these figures are for United States institutions of higher education only. "Philosophy" does not include departments of the history and philosophy of science. Compiled from the Directory of Members, History of Science Society *(3rd edition, 1974). These figures represent a total sample of 430 people, about a third of the membership. A large number of entries in the* Directory *do not include information on department, partly because the directory form does not specifically request it and partly because many people listed did not return the form. Only those whose departmental affiliation were either listed, identifiable from other information in the listing, or personally known to the member of the Committee who did this tabulation, are included. This amounts to about 2/5 of the U.S. membership.*

TABLE V

Subjects in Department Titles in U.S. Colleges and Universities Which Offer Ph.D. Training in the History of Science

History	17
History of medicine, health sciences, etc.	7
History of science	13
Philosophy	3
Philosophy of science	5
Science, etc.	2
Sociology of science	1
Other	2
Number of departments counted	35

NOTE

Compiled from Richard H. Schallenberg, "A Guide to Graduate Study and Research in the History of Science, Technology and Medicine," pp. 97-110 in Directory of Members. *All departments noted offer the Ph.D., but the survey does not note how many of these degrees are specifically in the history of science. Because of this and other ambiguities, this table can only be considered approximate.*

Appendix II

Exchange of Curriculum Information and Materials

The materials catalogued below were collected in 1972-1973 as part of a project for pooling and exchanging resource materials in the history of science, technology, and medicine. Teaching members of the History of Science Society were solicited by mail, and individuals representing over seventy universities in the United States, Canada, Great Britain, and Australia responded by sending in materials used in conducting their courses. These have been catalogued here in a simple and brief format so that interested members of the profession can identify items of potential usefulness, and request copies.

Two caveats are in order. Even when first collected, these items were an incomplete representation of the total teaching activities of the profession. Secondly, lack of funding has made it impossible to update the collection. We hope to remedy both of these defects in the near future.

Any classificatory scheme meets with difficulties. The following one is sometimes arbitrary and always subjective. Its aim was not to make judgments upon the materials, but to describe them in a way which would enable colleagues to decide which might be of interest and use in their own teaching.

Four broad groupings were employed:

1) General and Survey Courses in the History of Science
2) History of the Physical Sciences and Technology
3) History of Biology and Medicine
4) Social Implications of Science and History of the Social Sciences

Within these broad groups, individual items were alphabetized by institution.

Each entry consists of the following information:
Institution * Instructor * Name and Number of Course * Title of Course * Number of Pages
Abbreviations should be self-evident.

Following the entry is a sequence of six groups of codes which indicate respectively 1. Period, 2. Approach, 3. Format, 4. Level, 5. Duration, and 6. Nature of Materials. The key to these codes appears at the end of this introduction.

These materials, although kept for the present at UCLA, should be considered the common property of the profession. I shall be most happy to supply xerox copies at $0.20 per page (prepaid), postage included. To those who send in either new or updated curriculum materials with their order, the rate will be $0.10 per page. All correspondents will be sent the revised catalogue which will appear when warranted by the volume of additions.

I should like to thank Professor Harold Sharlin and the History of Science Society's Committee on Undergraduate Teaching for their encouragement, and for the funding which made this initial catalogue possible. I should like to thank also Mr. Allen Freedman, of the UCLA Department of History, who classified the major portion of these materials and prepared this catalogue.

KEY
Column 1 – Period
A = Ancient
M = Medieval
R = Renaissance
Numerals indicate inclusive centuries
Column 2 – Approach
HIP = History of Ideas and Philosophy
SP = Socio-Political
I = Interdisciplinary
NW = Non-Western
Column 3 – Format
L = Lecture
S = Seminar
D = Discussion
Column 4 – Level
L = Lower Division
U = Upper Division
G = Graduate
Column 5 – Duration
1 = One Quarter
2 = One Semester or Two Quarters
3 = More Than One Semester
Column 6 – Nature of Materials
L = Lecture Schedule
R = Reading List
B = Bibliography
S = Supplemental Materials (handouts, paper topics, etc.)
E = Examination

Robert G. Frank, Jr.
Medical History Division
Department of Anatomy
University of California
Los Angeles, California 90024

California (Los Angeles) * Westman * Hist 106A Science from Antiquity to 17th Cent * 1p	A/17	HIP	L	L	1	LR
California (Santa Cruz) * Olson * Hist 180A, B History of Science * 22pp	A/20		L	L	3	LRB
Clarkson (Potsdam, NY) * Kerker* History of Science * 1p	A/20		L	L	2	L
Columiba * Graham * W1003x, W1004y History of Science I, II * 15 pp	A/20		L	L	2	LR
Dalhousie (Canada) * Farley * Biol 390/Hist 310 History of Science * 2pp	16/19	HIP	L	L	2	S
Duquesne * Costa * Hist 543 Development of Modern Science * 1p	19/20		L	G	2	R

Duquesne * Costa * Hist 307/308 History of Science * 5pp	A/20	HIP/SP	L	U	3	LR
Earlham Coll (Richmond, Ind) * Bentley * ID 60 History of Science * 3pp		HIP/I	D	U	2	LRS
Glasgow * Swinbank * PROGRAM History of Science * 14pp	A/20	HIP	S	U	3	LRSE
Grand Valley State (Allendale, Mich) * Kopperl * Hist 310/311/312 * History of Science * 40pp	A/20		L	L	3	LRSE
Grinnell * Bowman * Hist/phys/Chem/Biol 252 History of Science * 16pp * Pres. Add. U Tenn	A/19		L	U	2	LRBE
Indiana * Westfall * X212 History of Modern Science * 2pp	17/19	HIP	L	L	1	LR
Kansas State * Eastwood * Scientific Ideas in History * 5pp	A/20	HIP	L/D	L	2	LRS
Kent State * Jackson * LibSci 481/581 History of Scientific Literature * 6pp		I	D	U/G	2	LB
Lafayette * Loose * Phil 15/16 History of Science * 11pp		HIP	L	L	3	LRB
LaGuardia CC (NY) * Gross * History of Science * 2pp	A/20	SP	L	L	2	LR
London (Coll St. Mark & St. John) * Ebison * History of Science PROGRAM * 33pp		HIP			3	BS
Manhattanville (Purchase, NY) * Weiner * Scientific Revolution in Western Culture * 36pp	16/19	HIP	L	L	3	LRB
Maryland * Brush * PROGRAM History of Science * 60pp						
Melbourne * Dyason * HPS 44-1 History and Philosophy of Science * 37pp	A/17	HIP	L	L	1	LRBS
New South Wales * Seddon * 62.123/133/114 History and Philosophy of Science * 2pp	17/19	HIP	LS	U	2	S
New South Wales * Seddon * 62.122 History and Philosophy of Science (Honors) * 1p	A/16		L	U	2	R
New South Wales * Seddon * 62.001/002 History and Philosophy of Science * 3pp	17/19	HIP/SP	L	L	2	RS
New South Wales * Seddon * 62.111 History and Philosophy of Science * 2pp	A/18	HIP	L	L	1	RSB
SUNY (Stonybrook) * Cowan * HIS 251/252 History of Science * 3pp	A/19		L	U	3	LRS
SUNY (Buffalo) * MacKnight * GenSci 225/226 Man and the Natural World * 40pp	A/20		L	L	3	LRBS
Oregon Coll of Ed * Postl * GS 411 History of Science * 14pp	A/19		L	L	2	LBS
Pennsylvania * McCormmach * HPS 200 Science Since the French Revolution * 17pp	18/20	SP	L	L	2	LRBS
Washington * Hankins * HST 311/312 Science in Civilization * 12pp	A/20	SP	L	U	3	LRES
Wesleyan * Gillmor * Hist 235/236 History of Scientific Thought * 19pp	A/19	HIP	L	L	3	LRE
Western Ontario * Plotkin * Med 440/540 History of Science * 50pp	A/20		L	UG	3	LRBES
Western Ontario * Plotkin * Science 200 History of Scientific Thought * 6pp	A/19	HIP	S	G	3	LRE
Wisconsin * Siegel * Hist 202 History of Science * 1p	17/20		LD	L	2	L
Wisconsin * Lindberg * Hist 201 Science from Antiquity to 17th Cent * 2pp	A/17		L	L	2	LR

Babson Coll (Boston)* McKeon *ST 400-407 Society and Technology * 2pp	A/20	SP	LS	LU	3	S
Boston Univ * Berendzen * PROGRAM Case Studies Project in the Development of Modern Astronomy * 21pp	19/20	HIP	L	U	3	RS
Brown * Dupree * Hist 186 History of Science and Technology in America (1865 to present) * 7pp	19/20	SP	L	U	2	LRSB

Brown * Dupree * Hist 185 History of Science and Technology in America (Before 1900) * 6 pp	17/19	SP	L	U	2	LRSB
California (Los Angeles) * Westman * Hist 240-o Renaissance Science: Platonism * 4pp	R	ST/HIP	S	G	1	LRB
California (Los Angeles) *Westman * Hist 108 Aspects of Medieval and Renaissance Science: The Growth of the Mechanistic World View * 5pp	M/R	HIP	L	U	1	LRB
California (Los Angeles) * Westman * Hist 197 The Spread of Copernicanism in England and Italy * 2pp	16/17	HIP	L	U	1	LRB
California (Los Angeles) *Westman * Hist 240-o The Structure of Scientific Revolutions: Kuhn and his Critics * 8pp		ST/HIP	S	G	1	LRB
California (Santa Barbara) * Pursell * Hist 174A,B History of American Technology * 2pp	18/20	SP	L	L	3	R
California (Santa Barbara) * Badash * Hist 106A,B,C * History of the Physical Sciences * 6pp	A/20		L	L	3	R
California (Santa Cruz) * Olson * Hist 189 Special Topics: Development of Atomic Theory * 5pp	17/20	ST	L	U	1	LB
Cornell * Williams * Hist 312 Scientific Revolutions * 4pp	A/17	HIP	L	U	2	LR
Cornell * Provine * Hist 312 Scientific Revolutions * 2pp	18/20	HIP	L	U	2	LRS
Delaware * Beer * C632E History of Chemistry * 48pp	18/20	SP/HIP	S	U	2	SB
Duquesne * Costa * Hist 542 Scientific Revolution * 1p	16/17	SP/HIP	L	G	2	LR
Georgia Tech * Kranzberg * HSST 351/352 (551/552) History of Technology * 9pp	A/20	SP	LS	UG	2	REB
Grand Valley State (Allendale, Mich) * Kopperl * Hist 480 * History of Mathematics * 3pp	A/18	HIP	L	U	2	LRE
Grand Valley State * Kopperl * Hist 410 History of Physics * 10pp	A/20	HIP	L	U	2	LE
Hebrew U (Jerusalem) * Bromberg * 87.601 Chapters in the History of 20th Century Physics * 7pp	20	HIP	L	U	2	LR
Hebrew U (Jerusalem) * Bromberg * 87.803 Philosophical Problems in 20th Century Physics * 15pp	20	HIP	L	UG	2	LBE
Kansas * Hetherington * History of Astronomy * 5pp	A/20	HIP	L	U	2	LRBS
Maryland * Brush * Hist 138/402 Development of Modern Physical Science: Lavoisier to Einstein * 27pp	18/20		L	L	2	BS
MIT * Sivin * 21.955 Chinese Science and Natural Philosophy * 15pp	A/16	NW/HIP	SD	UG	2	RBS
Melbourne * Clendennen * HPS 367-201 History and Philosophy of Science * 5pp (History of Mathematics)	A/19	HIP	S	U	2	RE
Melbourne * Home * History and Philosophy of Science: (Matter and Change) * 9pp	A/16	HIP	L	U	2	R
Miami U * Kullman * Mathe 477/577 Development of Modern Mathematics * 15pp	A/19	HIP/SP	L	UG	1	LRBSE
Miami U * Kullman * Math 281 History of Mathematics * 5pp	A/18	HIP	L	L	2	LRS
Missouri (Rolla) * Eisenman * Hist 270/374 History of Technology * 1p	A/20		L	L	3	RS
New York U * Peters * W77.0889 Occult Sciences in Antiquity * 4pp	A/M	HIP	L	L	2	LR
SUNY (Stonybrook) * Cowan * HIS 136 Technology in History * 4pp	A/19	SP	LD	L	2	LRB
North Carolina State * Mulholland * Western Technology in Society * 36pp	A/18		L		2	S
Papua (Lahara, New Guinea) * History of Science and Technology * 21pp	A/18		LS	L	2	LRS
Pennsylvania * Hamarneh * ResSem 203 Natural Sciences in Medieval Islam * 2pp	M	NW	S	G	2	E

Princeton * * Hist 596 Development of Electricity & Magnetism Theory * 9pp	19	HIP	L	UG	2	LRB
Princeton * Gillispie * HPS 393 History of Science & Technology * 22pp	18/20	HIP/SP	L	U	2	LRBS
Princeton * Mahoney * HPS 291 Scientific Revolution * 22pp	16/17	HIP	L	U	2	LRS
Princeton * * Hist 590 Scientific Revolutions * 10pp	16/19	HIP	L	UG	2	LRBS
San Francisco * Iltis * PhysSci 1,3,4 History of Physical Sciences * 85pp	A/17	HIP	L	L	3	LRBSE
Toronto * May * Mathematics since 1800 * 43pp	19/20	HIP	L	U	2	S
Virginia Polytechnic Inst. * LeGrand * Hist 3180 History of Science and Technology * 13pp	A/M	HIP	L	L	1	LRSE
Virginia Polytechnic Inst. * LeGrand * Hist 3280 History of Science and Technology * 8pp	16/18	HIP	L	L	1	LRSE
Virginia Polytechnic Inst. * LeGrand * Hist 3380 History of Science and Technology * 14pp	17/19	HIP	L	L	1	LRSBE
Western Ontario * Plotkin * Science 210 History of Astronomical Thought * 3pp	A/19	HIP	L	G	2	LRE
Wisconsin * Siegel * Hist 413 Development of Modern Physical Science * 2pp	18/20	HIP	L	U	2	LR
Wisconsin * Siegel * Hist 461 Roots of 20th Century Physics * 1p	19/20	HIP	L	G	2	R
Wisconsin * Lindberg * Hist 323 The Scientific Revolution * 7pp	M/17	HIP	L	U	2	LRB
Worcester Polytechnic Inst (Worcester, Mass) * Sokal * Hist 323 * History of American Science and Technology * 9pp	19/20	SP	L	U	2	LRS
Worcester Polytechnic Inst * Bowden * Hist 204 The Scientific Revolution * 1p	16/17	I/HIP	L	L	2	LR
York U (Toronto) * Leith * National 171A Nature and Growth of Physical Sciences * 192pp	A/20		L	L	2	LRSB

California (Berkeley) 5 Hahn * Hist 103S The Discovery of the Circulation of the Blood * 2pp	16/17		L	L	1	R
California (Los Angeles) * Veseltear * PH 109 History of Public Health * 19pp * Pres. Add. Yale University	A/20	SP	L	G	1	LB
Connecticut * Greene * International 296 Development of Evolutionary Concepts from Aristotle to Darwin * 55pp	A/19		D	U	2	RBS
Kent State * Dexter * History of Biology * 1p			LF	L		S
New South Wales * Seddon * 62.112 History and Philosophy of Science * 2pp	A/19		L	L	2	RBS
New York City Univ. (CUNY, Mt. Sinai) * Lyons * History of Medicine * 5pp		HIP	S	G	3	LR
Loma Linda Medical School (California) * Numbers * Science, Medicine, and Western Thought * 1p	A/20	SP	L	U	2	S
SUNY (Stonybrook) * Cowan * HIS 259/BIO 159 * History of Biology * 3pp	A/20	I	L	U	2	LRS
Pennsylvania * Adams * H&SS 201 Biology and Society * 3pp	18/20	SP	L	L	1	LR
Pennsylvania * Adams * H&SS 650 Seminar in the History of Biology and Medicine: Darwin and Darwinism * 3pp	19	SP	S	G	2	LR
Princeton * Cowan * HPS 395 * History of Biology * 4pp	A/20	HIP/SP	L	UG	2	LR
Princeton * Geison * HPS 492 Problems in Modern American Medicine * 13pp	19/20	SP	S	UG	2	LRB
Toronto * Stieb * Pharm 451 History of Pharmacy * 8pp	A/20	SP	L	G	2	LRS
Virginia Polytechnic Inst * LeGrand * Hist H224 Darwin and Social Darwinsim * 4pp	19	SP	D	U	1	LRBS

Western Ontario * Plotkin * 1st year medicine Medical History Course * 31pp	A/19		L	G	2	LRBSE
Wisconsin * Parascandola * Pharmacy 401 European and American Pharmacy in Historical Perspective * 44pp		SP	L	G	2	LRSE
Wisconsin * Parascandola * Pharmacy 606 Proseminar in Historical Studies of Pharmacy: Use and Misuse of Drugs * 35pp	18/20	SP	S	G	2	LRBSE
Yale * Viseltear * HSM 136a Health and Disease in 18th and 19th Centuries * 4pp	18/19	SP	L	UG	2	LB
Yale * Viseltear * MC 278a History and Public Health Policy * 2pp	20	SP	S	UG	2	L
Yale * Viseltear * EPH 114b Introduction to Public Health Policy * 22pp	20	SP	LS	UG	2	LB

Brown * Dupree * Hist 285 Proseminar in Science and Public Policy * 1p	20	SP	S	G	2	R
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Connecticut * Greene * Hist 207 Science and Society in the 19th and 20th Cent. * 7 pp.	19/20	SP	D	U	2	RBS
Connecticut * Greene * Hist 245 Science in American Society 1660-1860 * 36pp	17/19	SP	L	U	2	RBS
Grand Valley State (Allendale, Mich.) * Kopperl Modern Technology and Society * 17pp	19/20	SP	D	U	2	ELRS
LaGuardia Community College (NYC) * Gross * Politics of Health * 12pp	20	SP	S	L	1	S
Loma Linda Medical School (California) * Numbers * Hist 433 Historical Studies in Science and Religion * 7 pp	16/20	SP	L	UG	2	LR
Melbourne * Dyason * HPS IIC, IIIC History and Philosophy of Science: Science and Society * 9pp	A/16	SP	L	LU	2	R
New South Wales * Seddon * 62.113 Social History of Science * 2pp	17/20	SP	L	U	2	RS
SUNY (Stonybrook) * Cowan * HIS 135 Science and Society * 2pp	19	SP	L	L	2	LR
Pennsylvania * Adams * SC005 * Science Fiction * 12pp	20	HIP/SP	S	U	2	LRB
Pennsylvania * McCormach * GH10 Science Since World War II * 16pp	20	SP	S	U	2	LB
Washington * Hankins * Hist 215 History of the Development of the Atomic Bomb * 4pp	20	SP	L	U	1	LB
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Worcester Polytechnic Inst. (Massachusetts) * Johnson * Hist 420 History of Psychology * 3pp	A/20		L	U	2	LR